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EDITORIALS

" . . . By Accidents and Sagacity"

In the middle of the sixteenth century Christoforo Armeno [1] published a translation of an Arabian fairy tale entitled "The Three Princes of Ceylon."* This tale was later translated into German (1583) [2], and still later into English (1722) [3]. The English translation is available in the Library of the British Museum. A copy of the German translation is available at the Library of the University of Washington [2].

The tale is one of adventure and intrigue. It was probably first related in various forms by the story-tellers of the Arabian peoples as they sat around the evening fire. As such, it was designed and embellished to interest and stimulate the listener. To relate the tale in its entirety would require considerable space; however, the following incident characterizes many of the adventures which these Princes experienced.

During their travels in a certain country in the Near East they met a man who inquired if they had seen a camel as they journeyed that day. The Princes replied that they had not seen any camels, but that a lame camel with one tooth missing and blind in the right eye had recently passed along the way. Furthermore, this camel carried honey on the right side, butter on the left and a pregnant woman. When the man heard the Princes describe his camel in such detail, he immediately concluded that they must have stolen his camel and disposed of it and the merchandise it carried; so he rushed to his King and presented his tale of woe. The King could only agree with the evidence, and promptly incarcerated their Highnesses in the local dungeon. The punishment for such a crime was cutting off the thief's right hand, a fate which was to befall the Princes. Their appeal that they had not stolen the camel, however, was so eloquent that there was some delay before they were scheduled to lose their hands. Meanwhile another citizen found the camel and returned it to the owner who, realizing his mistake, rushed to his King and proclaimed the innocence of the Princes. They were promptly released and the King ordered baths, new clothes and a sumptuous feast with entertainment to make amends for the injustice perpetrated upon their Highnesses.

The King was sorely puzzled as to how the Princes knew so much about his citizen's camel when they had not seen it. During the course of the evening he inquired of the eldest Prince

[1] Peregrinaggio di tre giovani figluioli del re di Serendippo, per opra di M. Christoforo Armeno dalla Persiana dell' Italiana lingua trapportato. (Vignette.) Co'l Privilegio del Somma Pontefice, et dell' Illustriss. Senato Veneto per anni x.

* The Persian name for Ceylon is Serendip, variously recorded as Serendib, Sarendip or Sarendib.

[2] Die Reise der Söhne Giaffers aus dem Italienischen Christoforo Armeno übersetzt durch Johann Wetzel, 1583, herausgegeben von BOLTE, J. and FISCHER, H. Bibliothek des Litterarischen Vereins in Stuttgart, Cc viii. Tübingen, 1896. Library, University of Washington, 830,8, L 71b, v. 208.

[3] The Travels and Adventures of Three Princes of Sarendip. Intermixed with Eight Delightful and Entertaining Novels. Translated from the Persian into French, and from thence done in English. To which is added Amazonta, or, The Politick Wife, a Novel. London, 1722. Sold by W. Ahetwood at Cato's head in Russell Street, Covent Garden; and T. Edlin at Princes-Arms over-against Exeter-Exchange. Notes and Queries, vol. 5, Edward Solly, August, 1878.

how he knew that the camel was lame and blind in the right eye. The eldest Prince explained that they had seen camel tracks on the road with one print showing a dragging toe; hence a lame camel had passed that way. Further, the grass on the right side of the road was lush, green and uneaten, while that on the left was poor grass with many weeds yet all had been eaten close to the ground. "Obviously," said the Prince, "the camel's right eye was sightless." The discernment evidenced by these accidental observations astonished the King. Still curious, however, he asked the middle Prince by what means they had concluded that the camel was without one tooth and bore honey on the right, butter on the left and a pregnant woman. This Prince pointed out that they noted pieces of chewed grass had fallen from the camel's mouth, and that these were about the width of a tooth; moreover, there were drops of materials on both sides of the tracks. Those on the right had attracted ants while those on the left had attracted flies. The youngest Prince, not to be outdone, interrupted his brother at this point. "The passenger, oh glorious ruler, was a pregnant woman, for the camel halted very often while the passenger dismounted and rested. As the rider rose to mount the camel again, she used her hand to push herself up from the ground because of the weight she bore."

The King was so impressed by the insight of the Princes in understanding happenstance occurrences that he offered them great wealth and a noble position if they would remain in his kingdom. Their Highnesses thanked him for his kind offer but refused and continued on their journeys the following day.

As related in this episode, their Highnesses were frequently making unexpected discoveries, which were the result of fortunate accidents and keen discernment, of unlooked-for occurrences and penetrating insight.

Except for Sir Horace Walpole, fourth Earl of Orford, the obscurity of this Arabian fairy tale would have been complete. On January 28, 1754 [4], however, in a letter to his friend, Sir Horace Mann, he wrote as follows:

"This discovery, indeed, is almost of the kind which I call SERENDIPITY, a very expressive word, which, as I have nothing better to tell you, I shall endeavor to explain to you; you will understand it better by derivation than by definition. I once read* a silly fairy tale called, 'The Three Princes of Serendip.' As their Highnesses travelled, they were always making discoveries *by accidents and sagacity*, of things which they were not in quest of. . . ."

This is the derivation of that "very expressive" word, serendipity—the faculty of making happy and unexpected discoveries by accidents and sagacity.

The individual who enters one of the sundry areas of research presently accessible may shortly thereafter join the ranks of the followers of the three Princes of Serendip. The prerequisites essential for his union with this august body may or may not be recognized by himself; nevertheless, if he makes some contribution to his chosen field, then inevitably he must have the good fortune and mature intelligence that mark him as one of their Highnesses' subjects. As one reads the medical literature, it becomes obvious that most physicians are loyal subjects of these Princes.

By accidents and sagacity many important contributions have been made to the field of surgery. While observation is important, the importance of the observation can be appreciated only by those with a broad background of knowledge. May we, as a profession, continue as loyal subjects of their Highnesses, as serendipity aids us in all present and future endeavors.

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[4] Letters of Horace Walpole, Mrs. Paget Toynbee, vol. III, 1750–1756, pp. 203–206.

* The English translation was published when Walpole was five years old.

Pulmonary Hypertension and Cardiac Surgery

As greater numbers of cardiac operations have been performed, the role of pulmonary hypertension as a factor influencing the decision for operation has become more important. It may be a complicating factor at the time of surgical correction of many cardiac deformities or may develop during the patient's later life. The chief anatomic alterations associated or produced are thickening of the vessel wall and luminal narrowing of the small muscular pulmonary arteries and arterioles which may result in a high fixed resistance to blood flow. The degree of this resistance and the level of pulmonary artery pressure must be considered in deciding whether or not an operation may be performed with reasonable safety and benefit.

Changes in the lung associated with congenital heart disease usually accompany a left-to-right shunt. Their etiology, while not entirely clear, can be explained on the basis of postmortem observations and experimental studies. Initially they were thought to be congenital aberrations in the pulmonary arteries and arterioles just as the associated intracardiac defect is on a congenital basis. Currently, accepted explanations place their pathogenesis secondary to the sustained high pressure and blood flow in the pulmonary vascular bed created by the left-to-right shunt. Normally luminal narrowing and thickening of the vessel wall produce increased resistance during the fetal period and persist into neonatal life. If the shunt is large these alterations may continue and progress at a rapid rate until the shunt is reversed. During this sequence of events a varying clinical picture is presented by the patient. Initially high output cardiac failure, pulmonary congestion, recurrent respiratory infections and slow physical development are often seen. As resistance increases and the shunt reduces, the patient may be relatively free of symptoms and may enjoy a period of false security. Finally, as vascular changes and resistance progress, the shunt may reverse and the patient becomes cyanotic. Increasing dyspnea and physical incapacity often make life intolerable.

During the first phase, cardiac failure should be controlled by medical means because the patient is often too ill and too young to survive a corrective procedure. This is especially true if an open heart operation using extracorporeal circulation is required, because the mortality rate rises abruptly in the infant. An extracorporeal lesion such as a patent ductus arteriosus should be closed. If the shunt is between the ventricles and medical treatment is not effective, narrowing of the main pulmonary artery will control failure and halt the progression of pulmonary vascular changes. A corrective operation may be performed at a more optimum time.

The pulmonary artery pressure during the second phase is usually high. The degree and fixation of the resistance varies according to a number of factors that include pressure, blood flow, age and type of defect. Most patients will tolerate closure of the shunt during this period but the mortality rate increases as the level of pressure and resistance rises.

In the third group, when there is reversal of the shunt, the decision for operation should be made cautiously and reservedly. In a small number of patients, patent ductus with reversal of flow has been successfully closed, as have interatrial defects. The risk is considerably greater than with the uncomplicated defect, and benefit following closure is derived slowly especially in the case of the reversed ductus. The mortality rate accompanying closure of ventricular septal defects in patients with cyanosis has been so great as to make such an operation virtually prohibitive. Lillehei initially reported no survivors following operation in a group of patients with ventricular septal defects and severe pulmonary vascular changes. Subsequently his results have improved with the use of tracheotomy and positive pressure with oxygen. A promising procedure used successfully by Sirak and associates is the creation of a smaller decompressing shunt (which later may be occluded) between the systemic and

pulmonary circulations outside the heart at the same time the ventricular defect is closed.

The chief factor which determines the degree of benefit afforded by surgery in these patients is whether or not associated pulmonary vascular changes will regress. Previously it has been thought that only changes of medial hypertrophy regressed if the high blood flow and pressure were removed. It has also been thought that if, in addition, intimal fibrosis were present to a marked degree, regression very likely would not occur. Blank has recently found that experimentally produced changes of severe degree in the dog will gradually disappear if the inciting systemic pressure in the pulmonary artery is reduced to normal. While these changes are not entirely comparable to those in patients with congenital heart disease and while one cannot completely transpose biological changes in the dog to those in man, these findings are nevertheless encouraging. There are also clinical observations of patients who have survived corrective procedures to support the belief that regression does take place. These consist for the most part of progressively diminishing cyanosis, increased exercise tolerance and the gradual disappearance of dyspnea. Cardiac catheterization long after operation and, ideally, lung biopsies will be necessary to confirm adequately whether or not the degree of anatomic alteration is less.

Of interest is the development of acute pulmonary hypertension which may occur under certain circumstances during extracorporeal circulation. This situation may arise when there is a prolonged obstruction to pulmonary blood flow either in the right ventricular outflow tract or in the small muscular pulmonary arteries and arterioles. Littlefield has demonstrated in the dog that an obstruction to pulmonary blood flow will increase the volume of blood shunted from the systemic bronchial arteries to the pulmonary circulation. During total cardiopulmonary bypass, this bronchial pulmonary shunt can raise the pulmonary capillary pressure to hazardous levels so that irreversible pulmonary parenchymal hemorrhage develops, which frequently results in death. Temporary decompression is necessary in these instances to prevent the development and progression of intra-alveolar hemorrhage.

Changes in the lung vasculature associated with acquired deformities such as mitral stenosis tend to develop more slowly and are perhaps not generally so severe. It is thought that multiple small emboli may occur, some of which recanalize. Hanlon et al. produced mitral stenosis in dogs and found that pulmonary arteriolar constriction occurred before an increase in vascular resistance appeared. In the patient, arteriolar constriction probably also occurs and is followed by the gradual onset of medial hypertrophy and later intimal fibrosis. In addition, fibrosis occurs in the parenchyma of the lung reducing its elasticity and producing varying degrees of emphysema.

The level of pulmonary artery pressure in mitral stenosis is not nearly so high as with congenital defects except during exercise and emotional stress or in later stages of extremely severe stenosis. The absence of a sustained high pressure may be a factor in slowing the rate and degree of change. The measured level of pulmonary hypertension is not generally important in the selection of candidates for operation or in predicting the amount of improvement after valvulotomy. In patients in whom the diagnosis is not definitely established, pulmonary artery pressure measurements are important especially during exercise. If there is a significant rise, stenosis is present; if little or no change occurs, myocardial disease is probable. The anatomic changes in the lung appear to regress after valvulotomy. Some of the most dramatically improved patients are those in the older age group with long-standing stenosis. Janton followed up a series of patients with severe pulmonary hypertension four and a half to seven years after valvulotomy and found that the fall in pressure was at first gradual but ultimately profound.

There is a need for more accurate assessment of the status of the vascular bed in patients with heart disease and pulmonary hypertension. One can gain valuable information from catheter studies especially if drugs which influence the vascular bed are administered during this procedure and changes in resistance are observed. Preoperative lung biopsies also indicate the extent of arterial occlusion. In addition, a better uuderstanding of the influence of neurogenic stimuli and reflexes affecting blood vessels in the lung should further clarify this problem.

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Cancer of the Breast in Rockford, Illinois*

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SURGICAL educators for many years have considered the conventional radical mastectomy to be the procedure of choice in the operative treatment of cancer of the breast. Some investigators [1–3] have suggested that this procedure be extended to include dissection of the mediastinal lymph nodes. Others [4–6] have offered evidence to favor simple mastectomy. Hoping to clarify in our minds some of the confusion resulting from these conflicting opinions, we have studied the results of surgically treated cancer of the breast in our own community. The findings of this survey were so unexpected and so interesting we felt them worthy of reporting.

The material consists of all patients (448) with cancer of the breast treated surgically in the three Rockford, Illinois, community hospitals (Rockford Memorial, St. Anthony's and Swedish-American) between 1924 and 1952. The pathologists in these hospitals have been specialists and, except for the earlier years of the study, certified in that field. Four hundred thirty-two patients (96 per cent) were followed up for at least five years and 294 for at least ten years. All deaths were considered due to carcinoma, and no cases were excluded even though a number of patients had evidence of distant metastases at the time of surgery, and many others died of unrelated causes.

The five- and ten-year survival rates for radical mastectomy were compared with those reported from large medical centers as well as with those from smaller communities. (Table I.) The consistency of these figures was surprising and, in itself, a stimulus for further investigation. It did not seem reasonable to expect the same results from our local hospitals as from those institutions where surgery was performed only by recognized authorities, nor did it seem reasonable to expect that the results would be so similar in different institutions where such factors as case selection, surgical ability, and postoperative radiation and hormone therapy were all varied. We thought it would be interesting to analyze some of the factors which might be considered important in influencing survival statistics.

In Rockford, the surgical treatment for carcinoma of the breast generally has been radical mastectomy. Some surgeons have performed simple mastectomy as the procedure of choice regardless of the patient's age, state of health or clinical situation. In a few cases simple mastectomy was performed for palliation. The patients having simple mastectomy were, on the average, eight years older (sixty-four years) than those having radical mastectomy. In a few instances only local excision was performed. Three hundred twenty-four patients were subjected to radical mastectomy, ninety-seven had simple mastectomy, and eleven were treated by local excision alone. Some patients had radiation therapy in addition to surgery; others did not. No distinction was made between these two groups. Believing that the lethal potentialities of unresected axillary metastases might not be manifest in five-year survival figures, we have, when possible, presented ten-year figures as well. (Table II.) It is interesting to note that the magnitude of the surgical procedure had no effect on the survival figures. The end results of radical

*This study was made possible by grants from the Rockford Memorial Hospital Foundation and the Rockford Clinic.

TABLE I

COMPARSION OF SURVIVAL FIGURES FOR RADICAL MASTECTOMY FROM VARIOUS INSTITUTIONS

Author	No. of Cases	Five-Year Survival Percentages			No. of Cases	Ten-Year Survival Percentages		
		Over-All	With Nodes	Without Nodes		Over-All	With Nodes	Without Nodes
Harrington, 1952 [7] (Mayo Clinic, 1910–1946)	7,325	51	33	78	5,810	35	18	61
Lewison, 1955 [8] (Johns Hopkins, 1935–1940)	220	43	32	64	220	29	18	48
Moore et al., 1958 [9] (Community Hospitals, Muncie, Ind., 1935–1951)	307	54	31	73	184	33	22	44
Smith and Meyer, 1958 (Community Hospitals, Rockford, Ill., 1924–1952)	324	53	38	71	205	30	21	43
Nohrman, 1949 [10] (Radiumhemmet, Stockholm 1936–1941)	767	51	..	..	767	29	..	..
Nielsen, 1951 [10] (Radium Center, Copenhagen, 1931–1944)	544	56	..	..	544	33	..	..

mastectomy, simple mastectomy and local excision were almost identical.

It is to be presumed that patients undergoing radical mastectomy have been operated upon for purposes of cure. A few of those having simple mastectomy (thirteen cases), on the other hand, had their operation for palliation when there was little or no chance for cure. It would seem logical to compare the results of the two procedures when in both instances surgery was performed for cure. There were eighty-four cases of simple mastectomy in which the procedure was performed as the operation of choice by the operating surgeon and in which there was no indication of distant metastasis or other condition incompatible with five-year survival. Of these eighty-four patients, fifty-one survived for five years and twenty-six of a possible seventy-three survived for ten years, giving survival rates of 61 per cent and 36 per cent, respectively. (Table III.) These figures compare favorably with 53 per cent and 30 per cent, the five and ten-year survival rates for radical mastectomy.

Because the statistics might be biased by the older average age in the group subjected to simple mastectomy as compared to radical, we analyzed the effect of age on survival. For this study we compared five-year survival figures for various age categories among those patients undergoing simple mastectomy for cure. (Table IV.) The statistics indicate a better prognosis for the younger group due, in all probability, to the increased mortality from other causes in the older patients.

In an effort to ascertain the effect of surgical skill, we divided the surgeons into two groups. In one group, termed "experienced surgeons," we placed the men who were either certified

TABLE II

FIVE- AND TEN-YEAR SURVIVAL FIGURES FOR VARIOUS PROCEDURES

Procedure	Five-Year Follow-Up			Ten-Year Follow-Up		
	Total	Survivors	Per cent	Total	Survivors	Per cent
Radical mastectomy	324	173	53	205	62	30
Simple mastectomy	97	52	54	81	26	32
Local excision	11	6	55	8	2	25
Totals	432	231	54	294	90	31

TABLE III

FIVE- AND TEN-YEAR SURVIVAL FIGURES FOR SIMPLE MASTECTOMY

Purpose of Operation	Five-Year Follow-Up			Ten-Year Follow-Up		
	Total	Survivors	Per cent	Total	Survivors	Per cent
Cure	84	51	61	73	26	36
Palliation	13	1	7	8	0	0

TABLE IV
RESULTS OF SIMPLE MASTECTOMY PERFORMED FOR CURE IN VARIOUS AGE CATEGORIES

Age Group	No. of Cases	Five-Year Survival	Per cent
Over-all	84	51	61
40 and under	10	7	70
44 and under	48	31	64
65 and over	36	19	52
70 and over	32	16	50
75 and over	16	7	43

TABLE V
FIVE- AND TEN-YEAR SURVIVAL FIGURES FOR VARIOUS SURGEONS

Surgeon	Five-Year Follow-Up			Ten-Year Follow-Up		
	Total	Survivors	Per cent	Total	Survivors	Per cent
"Experienced surgeons"	200	105	53	121	36	30
"Occasional operators"	232	126	54	173	54	31

surgeons or who specialized in surgery and whose work we knew to be capable and thorough. In the other group, termed "occasional operators," we placed those men who did not have special training in surgery and who operated infrequently. Two hundred patients were operated upon by thirteen "experienced surgeons" and 232 by fifty-six "occasional operators." The "experienced surgeons" performed 176 radical mastectomies, twenty-two simple mastectomies and two local excisions. The "occasional operators" carried out 148 radical mastectomies, seventy-five simple mastectomies and nine local excisons. The results in terms of both five- and ten-year survivals (Table v) were unexpected. The group who operated infrequently obtained the same results as the experienced surgeons. Because it might seem plausible to suspect that the more skilled surgeons were treating the patients with more advanced disease, we compared the incidence of axillary lymph node involvement in the two groups. Radical mastectomy cases of the "experienced surgeons" had a node incidence of 50.8 per cent and those of the "occasional operators" 58.7 per cent. The pertinent point here is not that inferior surgery is ever acceptable but rather that the ultimate fate of the patient was not influenced by the quality of the surgery performed.

To determine the effect of duration of the tumor on survival statistics, we again divided the 404 patients, whose records specified duration, into two groups. In the first group were patients who had undergone surgery within six months after discovery of the tumor. Most of the subjects in this group had surgery within days or weeks after disease of the breast was found. The second group consisted of patients who were not operated upon for six months or more after finding their tumor and had, in many instances, known of their disease for many months and even years. While it is obviously impossible to know the exact duration of the disease, we believed that this division fairly well differentiated the patients treated early from those treated late. When one computes survival from the date of surgery, it is quite true that the patients treated earlier have a longer survival than the ones treated later, although the difference is less than one might expect. (Table VI.) When, however, survival was calculated from the date the

TABLE VI
COMPARISON OF SURVIVAL FIGURES FOR PATIENTS TREATED EARLY AND LATE (COMPUTED FROM DATE OF SURGERY)

Clinical Duration Prior to Surgery	Survival from Date of Surgery					
	Five-Year Follow-Up			Ten-Year Follow-Up		
	Total	Survivors	Per cent	Total	Survivors	Per cent
0–6 mo.	243	143	59	156	53	34
Over 6 mo.	161	77	48	111	32	29

TABLE VII
COMPARISON OF SURVIVAL FIGURES FOR PATIENTS IN TABLE VI (COMPUTED FROM DATE OF RECOGNITION OF TUMOR)

Clinical Duration Prior to Surgery	Survival Following Recognition of Tumor					
	Five-Year Follow-Up			Ten-Year Follow-Up		
	Total	Survivors	Per cent	Total	Survivors	Per cent
0–6 mo.	243	143	59	156	55	35
Over 6 mo.	161	97	60	111	41	37

tumor was first noted (Table VII), it was astonishing to see the similarity of survival rates between the two groups.

COMMENTS

The confusion in our minds relating to the treatment of cancer of the breast has not been resolved by this study. We had hoped to substantiate the excellence of the standard radical mastectomy and, in fact, to justify the use of even more radical procedures. Instead, we could demonstrate no reason for performing more than simple mastectomy. We had expected to find good cause to crusade for treatment at the earliest possible date. Instead, the facts indicate that the time of surgical intervention has no effect on survival time when measured from the onset of the tumor. We had anticipated showing the advantages of technical ability and meticulous surgery. Statistically, no such advantage could be demonstrated. In short, neither the type of operation, the duration of the tumor nor the skill of the operator made a difference in the ultimate outcome of the disease.

The results of this study are contrary to the usual concept of the treatment of cancer of the breast, but similar findings have been recorded by others. For instance, Park and Lees [*11*] write, "It has not been proved that the survival rate of cancer of the breast, using the five year survival rate as an index, is affected by treatment at all." Williams, Murley and Curwen [*12*] stated, "The most impressive finding in this series is the remarkable similarity in survival rate following different methods of treatment. It must, however, be frankly recognized that all methods of treatment may have been equally ineffective in prolonging life." Rosahn [*13*] was unable to show that the technical ability of the surgeon made a difference in the ultimate outcome.

It is difficult to reconcile our findings with the present concepts of carcinoma of the breast. None of the three factors presumed to be of greatest importance in its treatment could be proved effective. Some tumors seem destined to destroy the patient even though removed early, thoroughly and radically. In others, the opposite is true. Although we continue to practice early and radical surgery, it appears, as Crile [*14*] suggested, that the biologic characteristics of the tumor cell and certain qualities of host resistance are the all-important factors.

CONCLUSIONS

1. A statistical study is presented of 432 patients with cancer of the breast operated upon in community hospitals.

2. Neither the five- nor ten-year survival rates were affected by the type of operation, the duration of the tumor or the skill of the surgeon.

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Hemorrhage As a Complication of Reflux Esophagitis

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BLEEDING from peptic ulcers in squamous mucous membrane of the esophagus due to reflux esophagitis is generally considered to be of a slow, chronic nature and seldom rapid or massive. On the other hand, bleeding from the much rarer peptic ulcer of gastric mucous membrane in the esophagus (Barrett's ulcer) is recognized as often being massive [*1,2,13,19*]. A recent experience emphasized to us that peptic esophagitis of the first and more common variety (i.e., in squamous mucous membrane) can lead to rapid exsanguination. A search of our hospital records revealed a second similar case. A presentation of these two cases with an analysis of the literature forms the basis of this report. In this paper we will consider only instances of bleeding from ulceration in esophageal squamous mucous membrane.

ANALYSIS OF LITERATURE

Statistical tabulation of reported experiences is difficult, since each series considers a different sample with respect to the severity of the disease; two of the reports were concerned exclusively with patients who were operated upon, others were also concerned with medically managed cases. Nevertheless, certain conclusions are possible on the basis of findings recorded by eleven authors [*3,4,6,7,9–11,14–18*] presenting a total of 780 patients. The one feature common to all was the presence of symptomatic reflux esophagitis, and in actuality the incidence of bleeding in the exclusively surgical series was similar to the general trend.

The incidence and severity of bleeding in these 780 patients are shown in Table 1. Two hundred eight patients, or 27 per cent, presented with or gave a definite history of "gross" bleeding in the form of hematemesis or melena. This agrees well with the previously expressed observation [*8*] that 30 per cent of patients with symptomatic hiatal hernias report bleeding. Eighty-six patients, or 11 per cent, had "severe" bleeding, depressing their hemoglobin content to less than 10 gm. per cent and/or requiring blood transfusion. Excluding one series [*4*] in which there was not a full description of the severity of bleeding, "massive" hemorrhage occured in thirty-three of 650 patients for an incidence of five per cent. (Massive hemorrhage is defined as blood loss sufficient to produce shock, requiring repeated rapid blood transfusions or emergency operation.) More significantly, massive hemorrhage occurred in 20 per cent of patients having gross bleeding. There was a total of five deaths from hemorrhage reported in the combined series of 780,

TABLE 1
THE INCIDENCE AND SEVERITY OF BLEEDING REPORTED IN 780 PATIENTS WITH REFLUX ESOPHAGITIS

Severity of Bleeding	Per cent of Total Cases	Per cent of Gross Bleeders*	Per cent of Severe Bleeders†	Per cent of Massive Bleeders‡
Gross	27	100	...	...
Severe	11	41	100	...
Massive	5	20	45	100
Exsanguinating	0.6	2	6	15

* Gross bleeding equals hematemesis or melena.
† Severe bleeding equals hemoglobin at 10 gm. per cent or lower and/or requiring blood transfusion.
‡ Massive bleeding equals shock requiring repeated rapid blood transfusions or emergency operation.

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FIG. 1. Case I. Specimen at autopsy showing opened esophagus and stomach. The esophageal ulcer is immediately proximal to the esophagogastric junction, and the open end of the bleeding vessel is just visible at the superior edge of the ulcer (at the one o'clock position).

FIG. 2. Case II. Specimen at autopsy. The sharply demarcated ulcer again lies in the most distal part of the esophagus.

an over-all incidence of only 0.6 per cent, but an incidence of fifteen per cent of those patients who were bleeding massively.

Stated more emphatically, the data can be presented as follows: Of 100 patients with hematemesis or melena secondary to reflux esophagitis, forty-one will require intensive therapy of resultant anemia, twenty will require heroic management in the form of multiple transfusions or emergency surgery, and two will die of hemorrhage. (Table I.)

The following case reports present the terminal course of two patients with clinical reflux esophagitis.

CASE REPORTS

CASE I. A fifty-one year old white man (K. C. H. No. 340210), was admitted at 9 P.M., March 25, 1956, with a chief complaint of weakness. He had had melena for two days, and repeated hematemeses for twenty-four hours. Progressive weakness, dizziness and unsteady gait led him to seek care. A four-year history of postprandial "heart-burn" and "gas," relieved by large doses of soda and by maintenance of erect posture after eating, was elicited. An episode of similar vomiting, without weakness, occurred two years prior to admission.

Physical examination on admission disclosed the patient to be pale, apprehensive, thirsty and tachypneic with a blood pressure of 120/40 mm. Hg, pulse 130 per minute, and respirations 35 per minute. Physical examination was otherwise noncontributory. Laboratory work showed: Hematocrit 17 per cent, stool 4-plus guaiac positive.

The hospital course was as follows: Shortly following admission, the patient vomited bright red blood and the blood pressure became unobtainable. The administration of 1,000 cc. of whole blood returned his blood pressure to 140/80 mm. Hg and the pulse rate to 110. Two similar episodes occurred in the subsequent ten hours; each required 2,000 cc. of whole blood to maintain his blood pressure. At 10 A.M., on March 26, the hematocrit was 24 per cent, and transfer to the operating room for laparotomy was begun. A forth and final episode of hematemesis and shock occurred prior to operative intervention. The patient did not respond to the administration of whole blood and he died at 10:45 A.M., March 26. A total of 5,000 cc. of whole

blood had been given during the fourteen hours of hospitalization.

The findings at autopsy were as follows: The esophageal hiatus admitted three fingers and there was a sliding hiatal hernia extending 7 to 8 cm. above the diaphragm with a 6 cm. distal diameter. The wall of the esophagus was thickened and tough and there was marked fibrosis about the distal esophagus. The distal third of the esophageal mucosal surface was diffusely reddened and 1 cm. above the esophagogastric junction was a 2 cm. ulcer, with the open end of a 0.2 cm. blood vessel projecting from its base. (Fig. 1.)

Microscopy showed the ulcer to be in squamous epithelium, with no gastric mucosa immediately adjacent to it. Chronic inflammatory change with much fibrosis was present.

CASE II. A seventy-eight year old white man (K. C. H. No. 30486), was admitted on January 18, 1951 at 5:30 P.M., with a history of repeated hematemesis during the day and of tarry stools for four days. In December 1949, a symptomatic hiatal hernia had been repaired. Recurrence of symptoms required revision of the repair in February 1950. A left phrenic nerve crush was also performed in May 1950, with decrease of symptoms. The patient had never been known to have gastrointestinal bleeding prior to the presenting episode.

Physical examination on admission disclosed the blood pressure to be 70/40 mm. Hg, pulse 124, and respirations 43. The general examination was negative for abnormalities except for pallor, tachypnea and weakness. The hematocrit was 20 per cent.

The hospital course was as follows: Three thousand cubic centimenters of whole blood administered after admission raised his blood pressure to 100/60 mm. Hg and hematocrit to 32.8 per cent. His condition remained stable until 1 A.M., on January 20, 1951, at which time he again became hypotensive, but he responded to the administration of 3,500 cc. of blood, which returned the hematocrit to 33 per cent. A left phrenic nerve crush was performed with local anesthesia on January 20. His condition was stable again until 1 P.M., on January 21, when his blood pressure dropped to 70/48 mm. Hg. One thousand five hundred cubic centimeters of whole blood (total of 8,000 cc.) corrected the situation temporarily. Surgical intervention was considered but evidence of pneumonitis of the left lower lobe discouraged this course. At 9 P.M., January 21, 1951, the patient had a fourth episode of massive bleeding and died.

The findings at autopsy were as follows: The esophagus appeared shortened, with the distal 10 cm. thickened and firm. The hiatus admitted three fingers. One centimeter proximal to the esophagogastric junction there was a firm edged ulcer crater, 0.5 cm. deep and 3.0 cm. in diameter, filled with red clot. The open end of a firm walled 0.1 cm. blood vessel projected from the base of the ulcer. (Fig. 2.)

Microscopy showed the ulcer to be in squamous epithelium without evidence of malignancy or immediately adjacent gastric mucosa.

COMMENTS

From the foregoing, it is apparent that reflux esophagitis becomes a threatening disease once hemorrhage occurs. Definitive operative therapy should be considered earlier than is generally the case, and *must* be considered when bleeding becomes a prominent symptom during the course of medical treatment.

Many surgical procedures have been advocated for the elective management of these patients, and as yet there is no universally accepted technic. In the great majority, the basic problem is reflux of gastric juice into the esophagus, usually with an associated sliding hiatal hernia. Therapy for esophagitis is directed at reducing the digestion of esophageal mucosa by the acid-peptic fluid. There is no known way of reducing the inherent sensitivity of the esophagus, so treatment must be aimed at reducing the exposure to the acid-peptic mixture. Medical management, most useful in the early cases in which the esophagus is still soft and pliable, attempts to do so by liberal use of antacids and judicious postural habits.

Of all the operations, those restoring a cardiac sphincter mechanism so that acid-peptic reflux into the esophagus is prevented are ideal. There is much disagreement as to the nature of the cardiac sphincter, with some workers arguing for a purely physical or mechanical valve dependent upon an acute angle of entry, and others insisting that a muscular sphincter in the distal esophagus is the sole mechanism. We believe that while the distal esophageal musculature does function as a physiological sphincter, the architecture of the esophagogastric junction acts to protect or aid this "sphincter." Such a concept (considering that the acute angle of entry and the mucosal flap of the cardia are important in resisting reflux), demands that when a sliding hiatal hernia is present, esophagitis should be treated by repair of the hernia with restoration of normal architecture whenever possible. Individuals having a recurrence of symptoms after adequate repair, or having at the time of repair particu-

larly severe esophagitis or associated duodenal ulcer, should be given the added protection of a procedure designed to reduce volume and acidity of gastric juice. We prefer vagotomy and pyloroplasty for this purpose; others use partial gastrectomy. Procedures for esophagogastric resection, unless they include a substitution for the sphincter mechanism, will enhance the basic process of reflux. For the patient who has not responded to vagotomy and pyloroplasty, with or without hiatal repair, or who has progressed to marked stricture formation when first seen, jejunal interposition may be advisable. Substitution of a segment of jejunum for the diseased esophagus not only provides a conduit for food, but also by peristalsis of the jejunum prevents reflux of gastric juice onto the cephalad esophageal mucosa. The jejunum itself is much more resistant to acid-peptic digestion than is the squamous epithelium of the esophagus [*12*].

Patients presenting with acute and massive upper gastrointestinal hemorrhage and a history compatible with esophagitis should undergo esophagoscopy. With the source of bleeding identified in the esophagus, balloon tamponade or packing with Oxycel® [*5*] may prove lifesaving. Emergency suture-ligature of the bleeding point or resection may then be indicated. Emergency operation to control bleeding in the distal end of the esophagus due to esophagitis is a much more difficult task in those patients with a thickened and inflamed esophageal wall than it is in instances of bleeding esophageal varices, in which the esophagus is still quite soft and pliable.

CONCLUSIONS

1. Despite the prevalent opinion that massive hemorrhage does not occur from erosion of esophageal squamous mucosa, a review of the literature indicates that such a complication may occur in five per cent of all patients with esophagitis and in twenty per cent of patients with esophagitis who have hematemesis or melena. This observation is further substantiated by case reports of two fatal cases seen at the King County Hospital, Seattle, Washington.

2. Because of this danger of massive, and even fatal, hemorrhage, an episode of hematemesis or melena in the patient with esophagitis being medically treated is a definite indication for operative therapy, preferably as an interval elective procedure but sometimes as an emergency procedure.

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DISCUSSION

R. G. PINKHAM (Seattle, Wash.): Bleeding as a complication of esophagitis or esophagogastritis, in association with a hiatal hernia, is not an infrequent finding but esophagitis resulting in massive hemorrhage and shock is unusual in my experience. Certainly this presentation including the illustrative cases graphically reveals the seriousness of this complication.

It is only when esophagitis with or without demonstrable hiatal hernia complicated by stricture, hemorrhage or perforation occurs that surgical consultation is urgently requested. Frequently it is then too late to effect a relatively simple and satisfactory cure and radical treatment is mandatory. I know of few instances in surgery in which preventive procedures are more urgently needed than in the treatment of recurrent ulcerative esophagitis. This unfortunately is not always easily accomplished. If the patient possesses a demonstrable hiatal hernia, certainly this should be properly repaired. Esophagitis secondary to an incompetent cardiac sphincteric mechanism is usually more difficult to control. An attempt should be made to tighten the hiatus as well as to increase the angulation of the esophagogastric junction in the hope of preventing gastric regurgitation.

If the corrosive effects have progressed to esophageal ulceration and stenosis with contracture and displacement of the stomach into the thorax, surgical correction is more difficult and the results less predictable. I would not quarrel with the authors as to their suggested surgical management of this problem. It is essentially the same approach I have employed for the past ten years with satisfactory results.

I have seen only one case of severe esophageal bleeding secondary to esophagitis and hiatal hernia. This patient had undergone transfusion many times prior to my having seen her. X-ray films showed a hiatal hernia with marked esophagitis. Esophagoscopy confirmed the presence of an acute ulcerative esophagitis. Through a transthoracic transdiaphragmatic approach the hiatal hernia was repaired, vagotomy performed, and a gastroenterotomy established for drainage. This patient has done quite well during the past three years despite a heavy alcoholic intake.

I have had occasion to see and operate upon several patients with severe chronic bleeding and hiatal hernias with gastric ulceration demonstrated by barium meal. Several of these patients have had symptoms compatible with esophagitis and on esophagoscopy, esophagitis and ulceration of the mucous membrane were noted. Repair of the hiatal hernia in these cases has been most effective. If recurrent esophagitis should occur after hernial repair, I think one must then consider subtotal gastric resection or vagotomy and pyloroplasty to reduce the corrosive regurgitant effect of the gastric juices.

I have frequently worried that I might overlook a case of esophageal bleeding secondary to ulceration for bleeding from ruptured esophageal varices. A year or two ago I was asked to see a patient vomiting blood who was supposed to have cirrhosis of the liver and esophageal varices. Certainly the patient had a long alcoholic history to justify the suspicion. I passed a Sengstaken-Blakemore tube and the bleeding promptly stopped. He was transfused several times and three or four days later the tube was deflated and subsequently removed. An esophagram one week later showed no evidence of varices but a small hiatal hernia was noted. Liver function tests which were abnormal rapidly returned to normal and six weeks later an esophagoscopy examination revealed no evidence of varices. I am quite sure this patient bled from the lower esophagus secondary to esophagitis. Perhaps the use of a Sengstaken-Blakemore tube is of some value in these cases and should be instituted when the occasion arises. The placing of such a tube may aid in the differential diagnosis as well as in the control of acute bleeding.

J. E. MUSGROVE (Vancouver, B. C.): This discussion of bleeding associated with esophageal hiatal hernia should include reference to the work of Maisel, Cooper and Glenn. They have had success in treating this type of reflux esophagitis associated with hemorrhage by inducing pneumoperitoneum. This procedure breaks the negative pressure beneath the diaphragm, allowing the upper abdominal organs to ptose; the positive pressure pushes the left part of the diaphragm upward and by so doing tightens the musculature about the esophageal hiatus. Therefore the stomach drops back into the abdomen, the diaphragm is elevated and the hiatus is snugged up around the esophagus, thus preventing reflux and further bleeding. We have used this procedure with benefit in two cases.

G. EDWARD SCHNUG, (Spokane, Wash.): I wish to thank Dr. DeVito and his co-workers for bringing to our attention this quite unusual but very trying complication of reflux esophagitis. Massive bleeding from an esophageal peptic ulcer is extremely difficult to manage successfully. Performing a major operative procedure on a patient with massive persistent hemorrhage, regardless of the source, is attended with a high degree of risk. The hazards connected with performing an operative procedure for control of hemorrhage due to peptic esophagitis are increased by the very nature of the condition. The bleeding is coming from an ulcer located in a segment of scarred and stenotic esophagus. The more simple procedure of suture ligation such as is utilized for esophageal varices may not be possible. Other procedures which might

be effective are extensive and time consuming and fraught with danger in the presence of massive bleeding. Certainly non-operative procedures such as balloon tamponade, packing with Oxycel gauze, and cauterization should be seriously considered before resorting to a major operative procedure.

The authors have rightly emphasized the importance of actively treating and controlling reflux esophagitis before severe bleeding occurs. Other serious complications, such as perforation, deep penetration or stricture formation may appear in the neglected patient with reflux esophagitis. It is interesting to note that the authors found that all patients with bleeding from reflux esophagitis had preceding symptoms characteristic of the condition. In other words, the patients do have warning symptoms, and in most instances a diagnosis should be made and effective treatment instituted. If medical treatment fails, the repair of the usually associated sliding hiatal hernia is certainly indicated. The concomitant or subsequent use of vagotomy and pyloroplasty in cases of severe or resistant reflux esophagitis seems logical. Theoretically it should be more effective than subtotal gastric resection because the normal capacity of the stomach is maintained. In severe cases with stricture, esophageal resection with replacement by a jejunal segment is, of course, necessary. I think it is worth emphasizing the necessity of being positive that the bleeding is from a reflux esophagitis before therapy directed toward the lesion, either non-operative or operative, can be instituted. This will usually require visualizing the source of bleeding with the esophagoscope. With the source of bleeding established, the utilization of balloon tamponade would seem to be a reasonable procedure. I am not familiar with the results of the use of this treatment in this particular condition, and I would be interested to hear the authors' comment on that particular point. The packing of the lower esophagus with Oxycel gauze has been used and reported successful. In the usual instance of a patient with a severe upper gastrointestinal hemorrhage in whom there is no known or demonstrable hiatal hernia and no known history of peptic esophagitis, one is more seriously concerned with other more common causes of this type of bleeding. In the occasional instance of a patient with massive upper gastrointestinal hemorrhage it is difficult to determine the source of the bleeding. In the event operation becomes necessary it should be preceded by esophagoscopy. It is in these patients with bleeding of obscure origin that one might unexpectedly encounter a hemorrhage from an esophageal ulcer. This, to me, gives added importance to careful consideration of this problem since it is a condition which one could encounter quite unexpectedly in an emergency situation.

I have had no experience with the emergency operative treatment of reflux esophageal ulcers with massive bleeding. I have been unable to find information about the mortality rate which attends the emergency operative treatment of this condition. I would be interested to know the type of procedure the authors contemplated in addition to the phrenic nerve crush. The authors did find in the reported cases a mortality rate of 15 per cent in those patients with massive bleeding. Is it possible from the information available to break down the 15 per cent mortality rate to show the comparative results of those patients treated conservatively and those treated by operation?

Again I wish to congratulate Dr. DeVito and his co-authors on this very stimulating presentation.

Russell L. Johnsrud (Portland, Ore.): Dr. Harkins and his group have again presented us with an important paper on one of the facets of the problem of hiatal hernia. At this time, I would like to report a case of massive hemorrhage from the gastroesophageal junction in which there was no previous esophagitis or other lesions. The patient was forty years old and two weeks previously had suffered a moderately severe injury to the head. The usual signs and symptoms of upper gastrointestinal bleeding developed. In spite of blood transfusions, bleeding continued to the extent that surgery was indicated. At the time of exploration through a long gastrotomy wound, a linear lesion across the gastroesophageal junction was noted with active hemorrhage. This was controlled by suturing the lesion. The patient recovered uneventfully. There was no evidence of chronic esophagitis, hiatial hernia or portal hypertension. We believed that this was either a lesion of the Mallory-Weiss type or an acute stress ulcer.

Returning to the subject of hiatal hernia, I have been an advocate of the Allison procedure since it was published and I have published a modification of this repair. However, there is a complication of this repair which I have recently seen and which has been reported recently in the literature. This is a hernia which develops in the counter incision in the diaphragm. Our patient was seen one year after the original repair. She was then seven months pregnant and signs of obstruction of the colon had developed. X-ray films demonstrated that a good portion of the transverse colon had herniated into the left side of the chest. This was a herniation through the radial incision in the diaphragm which was repaired and the patient recovered. This is presented as a possible complication which should be borne in mind.

H. S. Ford (Victoria, B. C.): This report on massive bleeding from esophagitis associated with hiatal hernia was interesting.

In a recently published report upon the complications found among 153 cases of hiatal hernia, it was

noticed that hemorrhage was considered a complication in nine cases. It was massive in four patients, one of whom died. The remaining five had the more commonly expected gradual intermittent bleeding leading to anemia.

It would seem to me that the suggested use of the Sengstaken tube would be of value in handling the occasional cases of massive bleeding. Certainly it is apparent that bleeding can be fatal occasionally and one must be aware of esophagitis as a source of massive upper gastrointestinal bleeding.

W. H. Cole (Chicago, Ill.): Drs. DeVito and Harkins and their associates have presented a problem which is difficult to handle. Hemorrhage and perforation are serious consequences of reflux esophagitis, and one wonders whether all hiatal hernias should not be repaired, even if asymptomatic. The objection to such an approach, of course, is that many patients with asymptomatic hernias discovered during examination have managed quite well with their hernias for many years and will probably continue to get along another number of years without trouble.

I agree with their plan of treatment. Perhaps gastrojejunostomy is better than pyloroplasty as a drainage procedure, since it can be performed through a thoracic incision at the time of hernial repair.

Robert V. DeVito (closing): We have enjoyed the comments of the discussers and appreciate sincerely their interest in our presentation. A number of questions have been raised by Dr. Schnug as to the optimal plan of therapy for a patient with bleeding esophagitis. We cannot pretend to be experts on this problem, unfortunately, and in fact our attention was directed to the need for better therapy only after we had made errors in management. Nevertheless, we did believe it important to bring to your attention the potential severity of bleeding in reflux esophagitis, and the plan of therapy we have suggested for acute bleeding is admittedly based on surgical principles rather than wide experience. Certainly we should emphasize a "prophylactic" approach, i.e., control of esophagitis by appropriate technics before a threatening hemorrhage occurs.

Pectus Excavatum

SURGICAL EXPERIENCES IN THIRTY-FOUR CASES

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PECTUS excavatum is a congenital deformity in which the anterior wall of the chest is depressed, the lower sternum being the center of the depression and the adjoining costal cartilage and occasionally the medial portion of the ribs forming the lateral walls of the depression. It has been referred to by many names, the more common of which are: funnel chest, sunken chest, koilosternia, trichterbrust, thorax en entonnoir and chonechondrosternon. Pectus excavatum is the Latin term which in translation means hollowed breast. Perhaps the most accurately descriptive term is that one coined by Ochsner and DeBakey from Greek, chonechondrosternon [57].

The deformity usually is recognized at birth or shortly thereafter and apparently on occasion does not present until puberty [39,45,47]. It usually is progressive over a period of several years but many recede during very early years before the bony thorax becomes more rigid [12, 15,16,19,34,42,45,49,57,66,67]. From a combination of several large series, the incidence of 0.06 per cent has been determined [57]. Males are affected about three or four times more often than females [57,67].

Some of the earlier investigation on pectus excavatum was performed by Bauhinus, who in 1594 published a paper enumerating the clinical manifestations observed and proposed that the condition was caused by a shortened diaphragm [4]. About this same time Johann Schenck also published a description of the condition [57]. In the latter part of the nineteenth century a flurry of papers appeared from different medical centers, many of which were stimulated by the same patient, an intinerant medical student. Until the early 1900's the condition was often confused with the then more frequently occurring deformity of the chest wall caused by rickets [57].

ETIOLOGY

During fetal life and the first years of life, the sternum distal to the angle of Louis is very flexible and not well fixed. Thus, many earlier writers considered that external pressure on the easily depressed sternum was the cause of the deformity. Pressure on the sternum *in utero* by various parts of the limbs or by the chin has been reported as the etiology by numerous authors [57]. The pressure from the head of a twin was reported as the cause of the deformity in one instance [68].

Nutritional disturbance, defective ossification and abnormal loosening of the chondrosternal articulation have been thought to increase the flexibility of the sternum and thus the tendency toward pectus excavatum. Each has had proponents [57].

Muller [56] and Bien [5] noted that in the normal development of the embryo the sternum goes through a stage of depression. It was suggested that pectus excavatum resulted from the sternum remaining in this embryonic position. Arrest in growth of the sternum as a theory of etiology was invalidated by the finding of sternums of normal length in patients with pectus excavatum [57].

Syphilis has been implicated, only later to be disregarded [40]. Rickets produces a deformity of the chest wall and has been confused in the past with pectus excavatum.

There appear to be at this time four acceptable mechanisms by which pectus excavatum is

produced. These are: (1) by means of a shortened central diaphragm, (2) by overgrowth of the ribs and/or costal cartilage, (3) by malfunction of the pectoral muscles and (4) respiratory obstruction. Acute trauma may produce a depression of the sternum but this should not be considered as part of the entity of pectus excavatum. In considering these in order, the following may be said:

1. Autopsy studies have shown that the central tendon is short, at times only 1.5 cm. in anteroposterior diameter [*57*]. Bauhinus in 1594 was the first to suggest that depression of the sternum was caused by a shortened diaphragm. Woillez [*77*] was quoted by Ebstein as considering the lesion to be a result of contracture of the central tendon in a similar fashion as occurs in Dupuytren's contracture of the fingers. In 1939 Brown [*14*] published the early results of his limited operation in an infant in which he sectioned the diaphragmantic attachments to the sternum and the substernal ligament. Subsequently, many surgeons performed this operation [*7,18,24,34,37,42–45,50,52*]. This procedure stopped the retraction of the lower sternum which is present on inspiration in these infants. In many, this halted the progression of the funneling and corrected the deformity, although later there were some recurrences [*7,37, 24–45,50,52*]. The operation, however, did demonstrate clearly that the pull of the diaphragm associated with a short central tendon plays a major role in producing pectus excavatum. Brown and Cook believe that the cause of the shortened central diaphragm is due to a neuromuscular imbalance. By this theory they explain the various deformities in this area thusly: if the chest protrudes, the lateral fibers of the diaphragm are overstimulated, thereby causing a contraction of the thorax in its transverse diameter; if there is a depressed chest wall, the central fibers of the diaphragm are overstimulated, resulting in permanently fibrosed muscle and a depressed chest wall. Brodkin believes that the shortened central diaphragm is due to failure of the anterior portion of the diaphragm to develop from the embryological septum transversum and the resulting muscle imbalance [*10–13*].

2. In 1873 Flesch quoted Schiffer, his Chief, as considering pectus excavatum to result from overgrowth of the ribs [*26*]. It can be demonstrated at surgery that the ribs and/or costal cartiiages are too long. To allow the sternum to assume a normal position, the cartilages have to be trimmed back several centimeters [*34,39*]. Lester has pointed out that unequal overgrowth of the ribs would explain asymmetrical chest deformities, the occurrence of funnel chest in one twin and pigeon breast in the other twin, as well as a combination in which the upper chest is like that of a pigeon chest and the lower chest that of a funnel chest [*47*].

3. The inward pull of the diaphragm on the lower sternum is resisted by the bony thorax and the bridging softer costal cartilages. It has occurred to one of us (W. F. B.) that as the pectoralis major muscles course over the anterior bony cage and costal cartilages to attach near the midline of the sternum, they are bent as one would bend a bow. The tone and contractions of these large muscles tend to straighten the muscle into a straight line from origin to insertion and, in so doing, tend to pull the sternum forward increasing the convexity of the chest wall. Malfunction of the pectoralis major muscles would then tip the balance in favor of the inward pull of the diaphragm on the sternum. Thus, a case of pectus excavatum would be produced. We have in our series several cases of pectus excavatum in which the pectoralis muscles could not effect their outward pull for they were attached far lateral to the sternum. In another patient there was generalized muscle weakness. Here, again, the balance is destroyed and the diaphragm pulls the sternum inward. This is also true in another patient in our series in whom the right pectoralis muscles were greatly atrophied. The association of generalized muscle weakness and pectus excavatum has been reported fairly frequently. In their review of the literature Ochsner and DeBakey in 1939 found eight such cases reported [*57*]. Fruhwald [*27*], on the basis of two such cases, suggested that anomalous development of the pectoral and recti muscles may play an etiological role. (Figs. 1 and 2.)

4. As a causative factor, respiratory obstruction from such conditions as hypertrophied adenoids and tonsils has enjoyed much popularity in the past. Osler was a supporter of this theory [*59*]. However, with the advent of endotracheal anesthesia and chest surgery it became apparent that with an endotracheal tube in place to give a free airway, the sternum in infants still retracts with each inspiration [*34,43,47*]. This is most convincing evidence that respiratory obstruction could only rarely

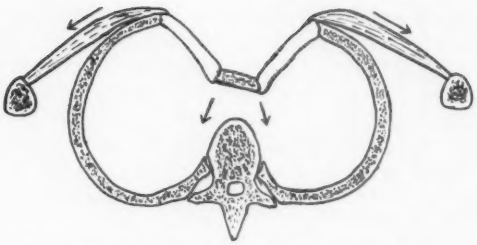


FIG. 1. In many cases of pectus excavatum, the pectoral muscles are markedly underdeveloped or actually arise near the nipple line so that their contraction does nothing to overcome the pull of the diaphragm. With passage of time the costal cartilages become abnormally long so that the sternum cannot attain a normal position until cartilages have been resected.

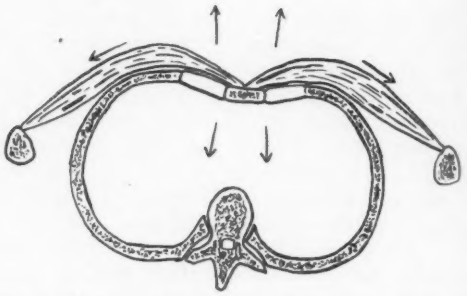


FIG. 2. After resection of the costal cartilage and sternal osteotomy, the sternum can be brought up into normal position. Reattachment of the pectoral muscles in the midline of the sternum allows their contraction to pull the sternum forward, thus tending to maintain the position of correction and overcome diaphragmatic pull. One of our patients has incomplete stability of the chest wall postoperatively and well demonstrates this principle; by contracting his pectoral muscles he pulls his chest wall out into complete correction. Physical therapy aimed at strengthening pectoral muscle tone is resulting in improved position.

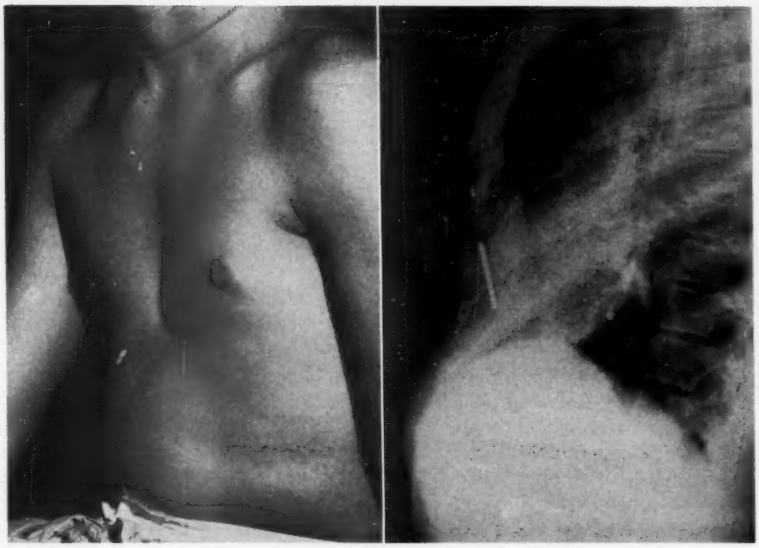
be the cause of a funnel chest. Hausmann [*34*] has observed two such cases, however, in whom after laryngeal stridor had been corrected the depression decreased to non-surgical proportions.

Despite the diversity of theories of etiology, all agree that a large percentage show a familial tendency. Lester and Sainbury have found this to be a recessive trait in most instances although occasionally it is dominant [*70*]. Brown and Cook demonstrated an incidence of associated anomalies of 31.8 per cent in a series of forty-four cases [*15*]. Other series, however, do not bear this out ([*34,52,69*].

ANATOMICAL AND PATHOLOGICAL CONSIDERATIONS

The sternum consists of three parts from above down: the manubrium, the gladiolus or body, and the xiphoid. The manubrium is stable and is joined superiorly on either side by the clavicles. It forms a true joint with the gladiolus, and the second ribs join the sternum at this level. This forms a protuberance named the angle of Louis. The gladiolus is the longest part of the sternum and is joined by the second through the seventh costal cartilages. It is made of four parts which fuse. Distal to the gladiolus is the xiphoid which is small and triangular in shape, forming the tip of the sternum. Later in life it fuses with the gladiolus. To it is attached the linea alba and the more medial aspects of the recti muscles. Beneath the sternum is a membrane of dense fibrous tissue which spreads out on the adjoining costal cartilages, surrounds the costosternal joints, and is continuous with the linea alba caudally. To this membrane Brown has given the name "substernal ligament" [*14*]. The diaphragm joins the "substernal ligament" at the level of the sternoxiphoid junction by means of two fibrous slips. Laterally, the diaphragm is attached to the lower six ribs by diffuse fibrous attachments. The diaphragm is made up essentially of peripheral muscles radiating into a centrally placed aponeurotic membrane named the central tendon.

As a result of the depressed anterior wall of the chest, there is encroachment on the thoracic and upper abdominal structures which in most cases is physiologically inconsequential but may be of such extent that severe symptomatology is produced. The point of maximum depression occurs at or near the sternoxiphoid junction where the diaphragm is attached. The xiphoid may be pointed in almost any direction from directly posteriorly to almost directly anteriorly. The depression most commonly begins at the manubrosternal junction. The gladiolus is usually turned obliquely facing to the right but may face to the left. Thus, the greatest depth of depression is usually to the right of the midline. Laterally, the depression in most all cases begins at the costal cartilage junction but may begin several centimeters to either side. Due to the obliquity of the sternum, the side wall to which the sternum faces is steeper and that side of the thorax is smaller. Because of the depression the ribs character-



3 4

FIG. 3. This young soldier was ridiculed by his associates in the barracks and refused to go swimming because of his embarrassment. He claimed some shortness of breath on exertion.

FIG. 4. A lead marker at the depth of the depression shows some diminution of the anteroposterior diameter of the chest but not enough to be physiologically significant.

istically converge on the sternum in a more caudad direction, forming an acute angle with the sternum. The sternum may come to rest almost on the anterior surface of the vertebral column or actually may even be depressed into the paravertebral gutter [*66*]. This is usually at the level of T10. Frequently, the lordotic curve of the spine is increased and occasionally scoliosis occurs with the concavity toward the side to which the anterior surface of the sternum faces. Classically, the patient is round-shouldered, hollow-chested and potbellied. These characteristic deformities may be produced by the tight substernal ligament, for Brown has shown that these deformities may disappear after severance of the substernal ligament [*15*]. (Fig. 3.)

If the depression is of enough severity, the heart is pushed to the left or occasionally to the right [*6,8,15,44,52,53,73*]. The heart usually also is caused to rotate on its longitudinal axis [*8,32,53,75*]. Rarely, the heart is compressed [*1,8,37,46,50–53,64,75*]. Ischemia of the myocardium at the point of compression may be produced especially when the heart expands in response to exertion [*6,52,75*]. The muscle may become necrotic in the area and fibrosis may occur. In addition, the vena cava and esophagus may be encroached upon. The liver may be displaced downward and/or compressed. Some have stated that dyspepsia, which is occasionally seen, is due to malposition of the stomach or irritation of the vagus nerves [*57*].

The capacity of the thoracic cavity is obviously encroached upon. (Fig. 4.) This is in part compensated for by an increased transverse and longitudinal diameter of the chest. Additionally, in some there is increase in the anteroposterior diameter of each hemithorax in the mid-clavicular lines [*57*], although many are quite flat across the entire chest. The lungs being quite collapsible naturally are the organs which suffer in size. Because of the changed configuration of the thorax, the mobility of the thoracic cage is decreased. The ribs do not elevate easily, thus decreasing the effectiveness of the respiratory effort [*1,15,42,44*]. If the pectus excavatum is severe, these factors are reflected in a decreased vital capacity [*9*] and a decreased maximum breathing capacity [*15*]. In most cases, however, these studies reflect no abnormality although very often a history com-

patible with a somewhat lowered respiratory reserve or a history of repeated respiratory infections is obtained [1,15,25,37,39,44,50,52,66,67].

The diaphragm has few muscular fibers in the anterior portion at the site of the deepest depression of the sternum [12,78]. It typically rides low and each contraction in the infant pulls the depression inward in a paradoxial motion [12,15,16,18,19,34,39,42,44,45,52,64,66,69].

CLINICAL MANIFESTATIONS

Typically, the patient is of asthenic habitus and is rather tall. The most common complaint is that of embarrassment over the depression and usually this is the only symptom of which the patient is aware [1,8,43,44,66,69,73]. The patient may be somewhat neurotic because of abuse and teasing directed at him. Following surgical correction, frequently the patient first realizes that he did have a pre-existing physical disability. He notes he has an increased ability for physical exertion, and parents occasionally state that their children no longer have the number and severity of respiratory infections which prior to surgery they thought to be normal [19,39,42,44,54,64,66,67].

Others will complain of a variety of symptoms, of which dyspnea, palpitation, precordial pain, fainting spells and easy fatigability are more common. Thus, many are labeled with the diagnosis of neurocirculatory asthenia [11,53]. The palpitation may be part of a neurosis but may be due to arrhythmias which are produced by irritation of the myocardium by pressure from the depressed sternum [21,53,63,64,67,73]. The pain may also be on a neurotic basis or may be due to myocardial ischemia as a result of pressure on the heart [6,52,75]. The pain then may take any of the various patterns seen in ischemic heart disease. Uncommonly, pectus excavatum may be the cause of severe exertional dyspnea and even cyanosis which, in most cases, is on a cardiac rather than a respiratory basis [42,43,46,66,75]. Heart failure can be produced by pressure on the heart [17,18,20,21,37,45,53,63,64,75]. Distortion of the heart chambers, valvular deformity with incompetency and severe twisting of the great vessels with resultant interference of heart function has been observed [21]. Quite commonly, however, the occurrence of severe exertional dyspnea or cyanosis is on the basis of other associated diseases such as a congenital heart or severe bronchiectasis [12].

Systolic murmurs are present frequently and usually are located in the apical area or along the left sternal border [12,33,50,53,73,76].

In very severe depressions, esophageal obstruction with resulting dysphasia may be produced. Dyspepsia may also occur, apparently due to displacement of the stomach or irritation to the vagus nerves [57].

Roentgenographic examination in the anteroposterior view shows that the ribs converge on the sternum, forming more of an acute angle than in the normal person, and the lower ribs are abnormally long. If the heart is not displaced but is compressed, a radiolucency is seen in the area of compression in the cardiac silhouette. The left border of the heart is occasionally straightened and the aortic knob obliterated. If the heart is displaced, it is in most every instance to the left. In this case an accentuation of shadows is found in the medial aspect of the right lung base which is probably due to compression of the lung and the viewing of the angled costal cartilages in more of an end-on position. This shadow may be suggestive of atelectasis, pleural thickening, pneumonitis or tumor. If the right border of the heart is brought in line with the vertebral column by the displacement, an illusion of enlargement may be produced. In the left oblique view, the aortic window and retrocardiac space are encroached upon or obliterated [23,28,38,42,52,53,72,74].

The electrocardiogram shows no characteristic changes. There are changes, however, that are observed. Often there is right axis deviation, and often there is a persistence of the "juvenile pattern" with the inverted T waves in the precordial electrocardiogram. Arrhythmias are not uncommon and there may be runs of ventricular tachycardia due to direct irritation of the right ventricle. P wave changes, elevation of the ST segment and decrease in the amplitude of the QRS complex in lead 1 have been found but, again, are not characteristic [21,22,53,73–75].

SURGICAL TREATMENT

It is now well accepted that methods of treatment of pectus excavatum other than surgical are of little or no avail. Belts and appliances have been discarded. Physical therapy in the form of deep-breathing exercises and correction of posture is now recognized as beneficial

only when used in conjunction with surgery. Because of the "bowstring effect," strengthening of the pectoral muscles is of aid in holding the sternum in the desired position following surgery.

The indications for surgery are cosmetic, psychic and physiologic. Although most patients desire surgery on the apparent basis of esthetics alone, many later find that after surgery there was a physiologic defect present which was unknown until relieved by the operative procedure.

The correction is prophylactic, for the disease is usually progressive during the years of growth, and the dorsal kyphoscoliosis becomes fixed as does the bony cage and the round-shouldered posture. In addition, the decreased breathing capacity and ineffectual cough caused by the low, short diaphragm and relatively immobile ribs can be in some extent corrected, and thus the lungs are subject to fewer infections. Although it is not substantiated, it would seem that in later life the additional respiratory and in some cases additional cardiac reserve made available by early correction of the funnel chest would make a longer and more active life possible.

The psychic trauma suffered by the sensitive personality of the youngster abused by the teasing of unknowingly cruel playmates cannot be overemphasized. Inferiority complexes grow especially in little boys who pass through the stage of idolizing mythical heroes who classically are broad, square-shouldered, big-chested men. Many will not get the proper amount of exercise for they shy away from athletics where their physique is carefully scrutinized by their playmates. In the past, surgery was recommended only for those patients with severe symptoms. Lately, most are corrected for cosmetic and secondarily for physiologic reasons.

Gross has stated that surgery should be delayed and performed between the third and fifth year for some will outgrow the deformity [*31*]. Lester has found that in his large series the best results have been obtained in those patients between two and a half and four and a half years of age [*42*]. Hausmann in his observation found that all infants who had large depressions or a great amount of paradoxical motion did not improve, while many of the patients who had small defects and little paradoxical motion did improve [*34*]. Others have found no satisfactory reason to withhold surgery on the infant [*64*]. Certainly, few would delay surgery to reach this more favorable age in an infant who was having symptoms of any degree. On the other hand, after the age of five or six the bony changes in the ribs and spine are becoming fixed and in some the chest becomes flattened. The majority of the older age group, then, do not obtain as good results [*1,6,7,15,18, 36,42,43,45,49,66*].

In 1911 the first attempt at correction of pectus excavatum was made by Ludwig Meyer [*54,57*]. The patient had marked dyspnea and had associated pulmonary tuberculosis. Two and a half centimeters of the second and third right costal cartilages were resected. This obviously was of little or no benefit. Sauerbruch in 1913 resected the fifth through the ninth costal cartilages on the left, including a portion of the adjacent ribs and sternum, with relief of dyspnea and palpitations [*71*]. Zahradnicek in 1925 reported a satisfactory result after applying traction to the sternum of a sixteen year old boy by means of silver wires [*79*]. Knowing how fixed the sternum is at this age, and even at times in infancy, many have doubted his reportedly satisfactory results. Hoffmeister in 1927 reported a successful operative result by Lexer who resected the fifth through the ninth costal cartilages bilaterally and sectioned the sternum at the level of the fifth chondrosternal junction, turning it over so that the anterior surface became the posterior surface [*35*]. The complete freeing of the sternum was later found not to be necessary. Alexander in 1931 performed a T-sternotomy with the horizontal section just below the second chondrosternal junction in association with bilateral division of the fourth, fifth and sixth ribs and the seventh, eighth and ninth costal cartilages [*2*]. The results were successful, as was a case reported at the same time in which he resected not only the body of the sternum from the level of the second to the sixth costosternal junctions but also the depressed adjoining costal cartilages. This left an avenue for herniation of the heart and lung and also left these strictures unprotected. These types of corrections with various modifications carried out by several surgeons at that time resulted in a high death rate and in some high recurrence rates. In 1931 Sauerbruch, after finding that the previous operations he had performed produced disturbances in respiration, reported a method used with complete

success in which he resected small segments of the fourth to the eighth costal cartilages bilaterally and then exerted traction on the sternum by means of silver wires attached to an overhanging frame on the patient's bed [*71*]. In 1934 Gardinier [*29*] and Obredanne [*58*] reported on the operation which is essentially that used today except that they advocated a two-stage procedure. In the first stage, a section of the third through eighth costal cartilages was removed on one side. In the second stage, a similar procedure was performed on the opposite side combined with cuneiform excision of the sternum at the level of the second interspace and maintenance of traction by wire to a plaster cast previously fitted to the patient. In 1939 Brown published his classic paper in which he described the substernal ligament which, connected to a short diaphragm, held the sternum in the depressed position [*14*]. He devised the well known "simple operation." The procedure is essentially that of approaching the substernal ligament through a short incision through the xiphogladiolar junction with transverse section of the ligament. This in many instances allows the sternum to seek a normal level. This procedure was still recommended by Brown and Cook for infants between eighteen and twenty months of age in 1951 [*16*]. However, it has been reported that in the majority of cases, the substernal ligament is found to be a gossamer structure which could not possibly be of enough strength to hold the sternum in the depressed position [*1,7,34, 39,64–66,69*]. Most authors in recent years have reported that there are high recurrence rates following this simple operation [*7,41,42,45.50, 52,61,69*]. It would seem that in this day and time with the negligible risk of a more extensive procedure, the simple operation should be abandoned except in the rare instance in which the infant is severely affected by the depression, found to be a poor operative risk, and is found at surgery to be relieved at least temporarily by the procedure. The more extensive procedure consists of (1) excision or multiple section of the curved-in, extra-long costal cartilages, (2) cuneiform wedge osteotomy of the sternum at the site of beginning depression to elevate the sternum easily, and (3) fixation of the sternum in the newly attained position. To accomplish each, there are several methods. Each deformity is different and so tailoring of each deformity is necessary.

TECHNIC OF COSTOSTERNOPLASTY

Incisions differ in the male and female. In females a transverse submammary incision gives better cosmetic results. In the male a curvilinear incision away from the midline either to the right or left from the xiphoid to the second rib is suggested. In infants an incision following the costal margins may be used, for the procedure is usually less extensive in this age group. In any event a midline incision is avoided in order to prevent the very frequent tendency to keloid formation. After right and left or superior and inferior skin flaps have been raised by sharp dissection, the pectoral muscle attachments to the sternal border and costal cartilages are divided bilaterally to expose the deformed sternum and cartilages. In many instances, especially in adult patients, the pectoral muscles do not attach at the sternal borders but may be as far lateral as the nipple line. Furthermore, the pectoral muscles are usually markedly underdeveloped. In case the muscles do attach to the sternum, they are divided so that enough of the muscle attachment on the sternum is left to allow suturing of the muscles back to the sternum. Next, the xiphoid is isolated by sharp dissection and is excised, keeping out of the peritoneal cavity but necessarily dividing some of the attachments of the rectus muscles. A finger is passed into the anterior mediastinum beneath the sternum and the tissues are pushed to right and left. This pushes the pleura and internal mammary vessels laterally where they are less liable to trauma. When a finger is passed beneath the sternum in infants, the costal cartilages are gradually divided near the sternal border. Pressure with the finger allows the sternum to be elevated gradually to a normal position, restoring the convexity of the chest wall. In infants, the sternum is rarely seriously angulated and osteotomy usually is not needed. Furthermore, usually the cartilages are resilient enough to come up into position when the sternum is elevated. However, the lower cartilages at least should be divided and osteotomy performed if the sternum does not elevate nicely. In children and adults the costal cartilages may be resected subperichondrially or excision of the cartilages at the costosternal junction may be performed, often combined with cuneiform division of the cartilage and at times the ribs laterally in order to bring the chest wall forward. The resection

is begun at the costal margin, working superiorly alternately on right and left for the entire length of the deformity or until the sternum can be brought up into normal position. In children and adults and occasionally in infants, the angulation at the manubriosternal junction requires a wedge osteotomy through the anterior plate of the sternum at this point, fracturing the posterior plate to bring the sternum up into position. If desired, several interrupted silk sutures may be placed through the anterior periosteum across the site of the wedge osteotomy and, when tied, these ties hold the sternum in the corrected position. The costal cartilages will be much too long in cases in which a multiple division technic has been used so that the segments override. Sufficient lengths of each cartilage must be excised to correct this overriding. After excision of the excess length, the cut edges should just approximate the sternum. Not too uncommonly the sternum is S-shaped and two wedge osteotomies are required to straighten the sternum. In rare instances the sternum is "folded" on itself longitudinally, and here a longitudinal osteotomy must be added to flatten the sternum. If there is no paradoxical motion on respiration, no external fixation is needed. Usually in infants and children external fixation is unnecessary, while it is more commonly needed in adults. Careful check for pleural leaks is made at this point, and if any are found they should be closed with interrupted silk sutures with the lungs expanded. Usually, pleural leaks can be avoided. A catheter is placed in the newly created space beneath the sternum and is attached to suction as closure of the wound progresses. The catheter is removed after airtight closure is obtained. The pectoral muscles are reattached as far toward the midline as possible. This is very important for the pull of these strong muscles is a major factor in maintaining correction. External fixation is safest. For this purpose two heavy wires are passed around the sternum on large, curved, cutting needles. One is placed near the tip of the sternum and one near the mid-body, bringing the wires out through the skin. After reattachment of the pectoral muscles, the rectus sheaths are reattached to the costal margin and the skin is closed with interrupted silk. The retrosternal catheter is removed as the last stitches are tied. The wires around the sternum are brought through appropriate holes in a broad aluminum band which conforms to the convexity of the repaired chest wall. The wires are twisted tightly and a small dressing applied. (Fig. 5.) This prevents overcorrection as sometimes occurs with ladder-type fixation. Also, it obviates paradoxical motion, controls pain and maintains correction at the desired level. The aluminum band is left in place for three weeks and then the wires are removed. The aluminum band can be taped in place in children to prevent injury until strong fixation of the sternum takes place. A planned supervised program of physiotherapy to improve pectoral muscle function, chest expansion and general posture is highly worthwhile to attain good cosmetic results. During the operation it is important to avoid cutting into internal mammary arteries, opening the pleura and creating a midline scar. Early postoperative radiation of a midline incision may prevent the formation of keloids.

FIG. 5. After resection of cartilages and wedge osteotomy of the sternum, good correction was attained. Wires were passed around the sternum, brought out through the skin and through an aluminum band bent to conform to the contour of the chest wall. The twisted wires maintained correction for six weeks and then were removed. The aluminum band prevents loss of position, prevents overcorrection and obviates trauma in sleep or from playful barrack mates.

RESULTS OF OPERATION

It is impossible to present the exact results following the correction of pectus excavatum,

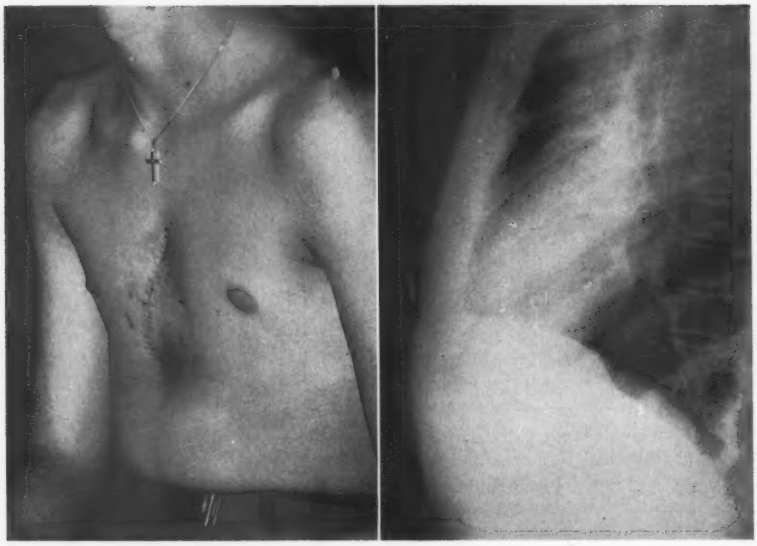


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FIG. 6. This photograph was taken shortly after removal of the aluminum splint and shows a satisfactory repair. The patient was so proud of his result that he kept his shirt unbuttoned, frequently went swimming and even went out for the judo team. The psychological result was perfect and he even claimed relief from his previous shortness of breath.

FIG. 7. The lead marker shows complete postoperative correction with good restoration of the anteroposterior diameter of the chest.

as obtained from the literature to date, for there is little of this recorded in exact terms, long term follow-up has been reported in relatively few instances, and in addition the number of corrections reported to date is not large. However, results can be given fairly accurately in qualitative terms.

It is apparent that good cosmesis results in over 90 per cent of the cases [*1,3,19,32,39,50,52, 64,66,69*]. (Fig. 6.) Very few poor results are obtained in infants whereas more are obtained in adults [*36,42–44,49,62,64*]. With correction there is amelioration of the psychic blemish and relief from embarrassment so that a more normal life is possible [*1,8,16,32,36,43,44,52, 62,64,66,69*].

Cardiac symptoms and arrhythmias are in most instances dramatically relieved [*9,21,32, 41,49,64,75*]. Distortion of the heart chambers and even valvular incompetency on a pressure basis has been demonstrated by angiocardiography to be relieved [*21*]. The damage that has already been produced to the myocardium itself, of course, is not improved. The heart often returns to a normal position, a more likely occurrence in the younger patient [*32,52, 63,64,67*]. Electrocardiographic changes tend to progress toward normal or return to normal in the immediate postoperative period in about 25 per cent of cases [*15*].

Relief of respiratory symptoms is surprisingly gratifying in most every instance [*19,44,52,66*]. (Fig. 7.)

Ochsner and DeBakey, in their review of the literature in 1939, reported six deaths in thirty-two operative procedures [*57*]. However, recent reports of mortality following correction of pectus excavatum are infrequent. Lester reported one death in ninety-four operations [*46*]; Ravitch reported one death from massive infection in a series of forty-seven operations [*64*]. Infection does not appear to occur any more often than in other clean procedures on the chest. Pneumothorax is reported quite frequently [*1,19,32,39,42,43,52,60,64,66,67,69*]. Atelectasis and pleural effusion are also frequent. Pneumonia and empyema occur too [*30*]. Laryngeal edema in infants following the use of

endotracheal anesthesia during the procedure has been reported as necessitating tracheostomy [42]. Formation of keloids is found almost universally in midline longitudinal incisions over the sternum [30,50]. Not infrequently overcorrection of the deformity results, which produces a pectus carinatum [30]. This must occur more often in those patients of surgeons who intentionally overcorrect the deformity at the time of surgery. The practice of overcorrection is based on the finding that there is frequently a tendency of the sternum to seek a lower level three to four weeks following correction [18,44,50]. The problem of instability of the sternum must be quite uncommon following surgery although some do take more than three weeks to become solid.

ANALYSIS OF CASE MATERIAL

There were thirty-four patients in our series, eighteen of whom were operated upon at Brooke U. S. Army Hospital (W. F. B., T. H. H.) and sixteen of whom were operated upon at Tripler U. S. Army Hospital (W. F. B.). The age range was between five months and twenty-six years. Seventeen patients were under the age of five years, six others were under military age and the remaining eleven were of military age. There were six females in the series, all under the age of seven. Necessarily discounting the number of the patients who were men in the service, there was a ratio of about four males to one female. Physiological symptoms, although quite mild in degree in most, were present in the form of frequent respiratory infection and/or dyspnea on exertion in sixteen patients. Thus, apparently physiological symptoms were present in approximately half the cases. The prime reason for surgery was physiological in three cases only, whereas it was cosmetic in the remaining thirty-one. It was believed either by the patients or the parents that the concavity was increasing in depth in six of the last fifteen patients from whom this information was specifically sought and recorded. Their ages were two, two, two and a half, four, twelve and twenty-one years. One would tend to doubt the case of the twenty-one-year old patient; however, he emphatically and repeatedly stated that the defect was getting larger and deeper. A positive family history was found in ten, or about one-third of the cases. It is of interest to note that in one family a mother and three siblings had varying degrees of pectus excavatum and, in the same family, two other siblings had mild pectus carinatum. Associated congenital anomalies were recognized in only three patients. Respiratory function studies were made of three patients and were found to be in the low normal range. A combination of pectus carinatum in the region of the upper sternum and pectus excavatum below was noted in three patients. This condition was repaired quite successfully with excellent cosmesis by excision of the prominence above, leaving the posterior table of the sternum in that area, and by elevation of the sternum below. In one patient, wedge osteotomy of the sternum in two places corrected the deformity nicely. Systolic heart murmurs were present in five patients. Roentgenography showed that the heart was pushed to the left in ten patients. Electrocardiography was performed in only four patients and gave essentially normal results in all. External fixation was used in thirteen of the thirty-four patients, six in children and seven in adults. This procedure was used far more frequently in the earlier operations than in later ones. It was found that silk sutures across the osteotomy sites and across the other areas of severance, if properly planned and executed, adequately alleviated paradoxical motion in almost every case. The external fixation wires broke in the immediate postoperative period in two patients. One, a twenty-six-year old powerfully built Negro man, had resultant paradoxical motion causing deep cyanosis. Rewiring of the sternum in the operating room effectively immobilized the sternum, although later the wound disrupted and drained for three months. In the other patient, a ten-month old Caucasian female infant, paradoxical motion resulted on crying but stabilization later resulted without operative intervention. There were two cases of wound infection, the one mentioned previously and one occurring in a two year old Caucasian male infant with generalized muscular dystrophy. Small amounts of fluid accumulated in the wound in five patients who were successfully treated by aspiration. Minimal pleural effusion occurred at the right base in one patient and cleared spontaneously. In four patients the pleural cavity was entered; however, only one showed evidence of postoperative pneumothorax on roentgenography. This was judged to represent 5 per cent collapse. Atelectasis of the right lower lobe occurred in

one patient; five other patients had fever postoperatively and it was believed that atelectasis, although not proved, was the most likely cause of the fever. In one patient who had had two bouts of pneumonia in the year prior to surgery, postoperative lobar pneumonia developed but cleared after antibiotics were given. Lastly, one postoperative febrile convulsion occurred in a three-year old child.

Cosmetic results have been good in all but two patients. However, a long term follow-up is not available on all patients. One unsatisfactory result occurred in a twenty-one-year old patient who had a very wide saucer-shaped deformity with the pectoral muscle attachments located far lateral to the sternum. The deformity was overcorrected, thus producing a pectus carinatum. In the other unsatisfactory result, the sternum changed to an oblique position postoperatively. Silk sutures at the osteotomy site were used as the method of fixation in this last case. The three procedures performed primarily for physiological reasons were quite successful in two patients. The third patient, a two-year old child with generalized myopathy and a history of repeated respiratory difficulty, had such a short follow-up that it is difficult to judge the result.

COMMENTS

There is little doubt that correction of pectus excavatum for physiological reasons is the only logical approach to the problem. This is also true for children in whom the deformity is obviously progressing. Correction of the deformity for cosmetic reasons has become feasible as better and safer methods of chest surgery have been developed. However, the procedure is not without danger, and complications, although usually minor and easily controlled, are fairly frequent. The postoperative course must be closely supervised; otherwise, the risk may be high in exchange for the cosmesis.

It is unfortunate that in order to correct a cosmetically undesirable deformity there is inflicted a cosmetic blemish in the form of a fairly large scar which usually hypertrophies or results in the formation of keloids. The patient's reaction to the scar, however, is usually remarkable in that it is accepted without comment and appears to cause little or no embarrassment. When asked to show his chest for inspection, he usually does it with delight and pride. Nonetheless, the keloid scar is undesirable and worthy of efforts to prevent it. We have used a curvilinear incision instead of a midline incision. Although the follow-up is incomplete, it is our impression that this does decrease the incidence of keloid formation. Postoperative prophylactic radiation of the incision was used in a few patients in our series but again the follow-up is incomplete. This, it seems, is worth investigation.

It has been our observation that the patient is quite pleased with an incomplete correction of the defect although the surgeon may not be as happy. In contrast, the patient is displeased if a pectus carinatum is produced. Thus it must be remembered at the time of surgery that some depression at the xiphosternal junction is normal and overcorrection should be avoided.

The procedure used in our series has been as varied as the number of patients. Each deformity was found to be different in some way. The radical procedure was used exculsively although some patients did not necessitate as extensive procedures as others. The substernal ligament was found to be of notable strength infrequently. Although we had patients with rib flare at the costal margins, none was believed to be severe enough to warrant correction. The type of deformity was found to influence the ease of repair and the result obtained considerably. The narrow, funnel-shaped, steep-sided deformity found most frequently in the infant was quite easy to repair and the cosmetic results were excellent. The steep-sided deformity with the initial bend in the sternum below the manubriogladiolar junction, producing a depression like one made by a baseball, was more difficult to repair but, again, the cosmetic results were excellent. The wide saucer-shaped deformity was found to be difficult to repair and the results were less satisfactory.

Although some have found that a defect results in the region of excision of the xiphoid [*50*], we did not find this so.

We did not use rib and cartilage struts beneath the sternum for fixation as some have done [*1,11,20,45,78*] nor did we employ Steinman pins or Kirschner wires, although their use by several different technics has been described as successful without significant incidence when they pierce the skin so that the metal is externally fixed [*30,36*]. Pins used without external fixation may be dangerous, as has been shown by a case in which a Kirschner wire migrated into the mediastinum [*55*].

This paper would not be complete without

mentioning the small series of young patients in whom correction of pectus excavatum was reported by means of prolonged traction on the sternum with wires placed into the sternum and without the use of an incision [25]. The results were reported as good. If a longer follow-up in a larger series finds this to be so, this type of procedure will certainly have a definite place in the correction of pectus excavatum.

One of the most interesting findings in our series was the family in which the mother and three siblings had pectus excavatum and two siblings had pectus carinatum. Lester has reported identical twins one of whom had pectus excavatum and the other pectus carinatum. These findings would seem to support the theory of overgrowth of the cartilage as the etiology of the deformity. Apparently by this means the type of deformity, that is, pectus excavatum or pectus carinatum, or a combination of the two, is produced in accordance with the position to which the sternum is displaced by the excessive growth of the cartilage.

Since we have become especially interested and aware of this abnormality, it has become evident to several of us through our daily observations that pectus excavatum is quite common and certainly more common than the 0.06 per cent incidence quoted. One of us (R. E. G.), in examining 652 ROTC cadets, found five cases of moderate to severe pectus excavatum and at least five more cases of mild or atypical deformity.

SUMMARY

1. A review of pectus excavatum is presented with an analysis of our series of thirty-four patients operated upon and a discussion of our experience.

2. Malfunction of the pectoral muscles is presented as one of the four etiologies of the congenital deformity. In addition, convincing support for the concept of overgrowth of cartilage as the etiology of pectus excavatum is found in our clinical material.

3. An incision away from the midline is recommended.

4. The need to tailor the deformity by varying the operative procedure for each patient is emphasized.

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Results of Treatment of Squamous Cell Carcinoma of the Anterior Part of the Tongue

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PRIOR to and in the early part of this century, radical surgical removal of malignant lesions of the tongue was difficult and was associated with a high mortality rate and considerable morbidity. As radiation technics became more standardized, many medical centers utilized them for treatment of these lesions. Although the primary oral lesion may be controlled by radiation, it was eventually learned that metastatic growths in the cervical lymph nodes were more resistant. In other centers, electrosurgical methods were used successfully in treatment of the primary oral lesion. Therefore, in the majority of instances, the primary lesions of the tongue were treated by simple excision or by electrocoagulation or radiation or both, and the cervical metastatic lesions were treated by some type of block dissection of the cervical nodes.

In more recent years, with the aid of antibacterial agents, advances in preoperative and postoperative nutrition, better anesthesia, and blood replacement, there has been a return to surgical removal of the primary lesion of the tongue and the involved cervical lymphatics. More recently still, these procedures have been extended to include *en bloc* removal of the primary lesion, the cervical lymphatics and the intervening tissue. Preliminary data from a few centers suggest that these procedures may be of value. At present, only a few reports of selected groups of patients treated by these methods have become available. In most series, these procedures have been applied only to lesions of the anterior part of the tongue.

It was the purpose of this study to determine the end results in all patients with squamous cell carcinoma of the anterior part of the tongue who had been treated at the Mayo Clinic from 1945 to 1954, inclusive, and if possible to determine the best method of treatment.

PRESENT STUDY

During the period 1945 to 1954, inclusive, at the Mayo Clinic, treatment of patients with squamous cell carcinoma of the anterior part of the tongue was individualized. During the early years represented by this study, the primary lesion was usually removed by local excision or widely destroyed by electrocoagulation, if it was deemed amenable to removal. With more extensive local lesions, interstitial use of radium or radon seeds, or the use of external radiation, or both, were employed in attempts to control the primary carcinoma of the tongue. In some instances, these methods of radiation followed removal of the local lesion by excision or electrosurgical means. In the later years represented by the study, hemiglossectomy and composite operations were used with increased frequency.

In general, at the Mayo Clinic, prophylactic dissection of the cervical nodes has been employed in the treatment of occult cervical metastatic lesions from carcinoma of the anterior part of the tongue. This, however, has been used on an individual basis, its application based upon additional factors such as age, general health, and extent and histologic grade (Broders) of the primary lesion. Some patients refused prophylactic dissections of the nodes. During the early years represented by this study, unilateral or bilateral dissection of the upper part of the neck (dissections of the sub-

mental, submaxillary and upper deep jugular nodes) as well as the standard radical block dissection was performed. Occasionally, block dissection of the cervical lymphatics with saving of the sternocleidomastoid muscle or the internal jugular vein was employed. During the later years represented by the study, the standard radical block dissection of the neck was employed more frequently, as a separate procedure or as part of a composite operation. In many of the patients whose primary lesions were treated by electrocoagulation, block dissection of the neck and ligation of the external carotid artery preceded treatment of the primary lesion. In certain instances the block dissection was extended to encompass the metastatic lesion (that is, removal of mylohyoid muscle); however, none of the extended retrohyoid dissections as described by Pressman were employed during the period represented by this study. Prophylactic radiation of the neck was used occasionally during the early years. Cervical metastatic lesions, if believed to be inoperable or if they occurred in aged persons, were usually treated with interstitial radon seeds or external roentgen rays, or both.

Factors of Selection. During the period 1945 to 1954, inclusive, 269 patients with histologically proved, invasive squamous cell carcinoma of the anterior part of the tongue (anterior to the circumvallate papillae) were treated at the Mayo Clinic.* These patients form the basis of this study. All patients with histologically proved, squamous cell carcinoma who received any form of treatment are included, regardless of how little the treatment or how short the period of observation. Patients with primary malignant lesions of the base of the tongue were excluded, as were those with primary lesions of the anterior part of the tongue other than squamous cell carcinoma. Patients with *in situ* carcinoma were excluded (ten cases). Five patients treated were excluded from this study because, on review, inadequate histologic proof of malignancy existed. Sixty-one patients received no form of treatment and were excluded; they came to the clinic for consultation only, refused treatment, sought treatment elsewhere, or were hopelessly incurable and returned home for palliative treatment. In the last group, histologic proof was not available in all instances. Likewise, some of these may have represented malignant disease other than squamous cell carcinoma.

Distribution According to Age and Sex. The ages of the 269 patients averaged fifty-nine years and ranged from twenty-six to eighty-nine years. Two hundred (74.3 per cent) were men and sixty-nine (25.7 per cent) were women.

Location and Extension. One hundred forty eight (55.0 per cent) of the tumors arose on the right, and 110 (40.9 per cent) on the left; in eleven instances (4.1 per cent) the side was not stated. The lesion arose from the lateral border of the tongue in 208 (77.3 per cent) patients, from the ventral part in twenty-five (9.3 per cent), and from the dorsum in six (2.2 per cent); multiple carcinomas were present in six (2.2 per cent) patients and the whole tongue was involved in one instance. The exact location of the lesion was not stated in twenty-three instances.

The tumor had invaded the floor of the mouth in forty-six patients (17.1 per cent), had extended to the anterior tonsillar pillar, tonsil, base of the tongue, or hypopharynx in thirty-six (13.4 per cent), had extended across the midline in twenty-two (8.2 per cent), and was fixed to the mandible in three. Clinically involved cervical nodes were present on admission in sixty-two patients (23.0 per cent).

Histologic Grade. The degree of undifferentiation of these tumors (Broders method) was recorded: 16 (5.9 per cent) were grade 1, 123 (45.7 per cent) grade 2, 112 (41.6 per cent) grade 3, and 18 (6.7 per cent) grade 4.

Previous Treatment. Sixty-four (23.8 per cent) patients had had some attempt made to control their tumors prior to coming to the Mayo Clinic (excluding biopsies, local applications, dental treatments and the like).

Multiple Carcinomas. Additional malignant lesions were present or later developed in thirty of the 269 patients (11.2 per cent). In eighteen, malignant lesions were present in other parts of the oral cavity; these have not been excluded in calculation of the survival data.

Treatment of Primary Lesion. The initial treatment employed at the Mayo Clinic for control of the primary lesion of the tongue is shown in Table 1. Since the first attempt at control of the lesion is the most important, it was believed that listing treatment of recur-

* During the same period, 102 patients with squamous cell carcinoma of the floor of the mouth and 118 patients with squamous cell carcinoma of the mandibular gingiva were treated here. These patients have been studied similarly [7,8].

TABLE I
SQUAMOUS CELL CARCINOMA OF THE ANTERIOR PART OF THE TONGUE: INITIAL TREATMENT OF THE PRIMARY LESION AT THE MAYO CLINIC

Treatment	No. of Patients
Excision (includes excision as part of a composite operation)	103
Electrocoagulation	68
Electrocoagulation or excision plus administration of radium or radon	62
External administration radiation, radium or radon	28
None (primary lesion believed controlled)*	8
Total	269

*Only treatment for cervical metastasis given at clinic.

TABLE II
SQUAMOUS CELL CARCINOMA OF THE ANTERIOR PART OF THE TONGUE: THREE- AND FIVE-YEAR SURVIVAL RATES

Period (yr.)	Patients		Lived beyond Indicated Period	
	Total	Traced	No.	Per cent*
3	269	246	133	54.1
5	217	199	92	46.2

* Based on traced patients. Inquiry as of January 1, 1958. Included in the three-year group are only those patients treated three or more years prior to the time of inquiry, that is, treated in 1954 or earlier. The five-year group comprises only those patients treated in 1952 or earlier. Hospital deaths are excluded from the calculation of survival rates.

rences would be confusing at this point. It must be appreciated that further attempts were made to control the primary lesion in those cases in which it was not controlled by these initial measures.

Some treated patients returned for follow-up examination and the efficacy of control of the primary lesion could be ascertained. A great number of patients, however, did not return so that complete follow-up was lacking. Therefore, it was impossible in many cases to determine whether the death of the patient was due to recurrence of the malignant disease or to other causes. Moreover, in those patients who, we were reasonably certain, died of oral cancer we were unable in many instances to ascertain whether the primary lesion was controlled.

Treatment of Cervical Lymphatics. In 186 cases (69.1 per cent) block dissection of the cervical lymphatics was performed as the first treatment of the neck (including dissections performed as part of a composite operation). Radon or roentgen therapy for the cervical lesions was used initially in twenty-nine cases (10.8 per cent). It must be remembered that these represent the first attempt at control of the cervical lesions, and obviously, if the lesion was not controlled by these methods, further measures were employed. Fifty-four patients (20.1 per cent) received no treatment of the neck at any time during the period represented by this study.

For the same reasons stated previously regarding control of the primary lesion of the tongue, it was impossible from the available data to ascertain the efficacy of control of the metastatic lesions of the neck.

Incidence of Involvement of Cervical Nodes. In this study we found that 242 prophylactic block dissections of the cervical nodes, that is, dissections of clinically uninvolved nodes, were carried out; this number includes dissections of the neck performed as part of a composite operation, and furthermore, bilateral block dissections were counted as two procedures. Histologically proved involvement of the nodes was found in thirty-seven (15.3 per cent) of the 242 cases.

Likewise, eighty-two therapeutic block dissections of cervical nodes, that is, dissections of clinically involved nodes, were performed. The nodes were metastatically involved in sixty-nine instances and uninvolved in thirteen (error rate, 16 per cent).

Crossed Metastasis. Histologic proof of cervical metastasis was available in 102 instances as a result of block dissection of the neck or excision of cervical nodes. Patients lacking histologic proof of involvement of the cervical nodes were excluded in this calculation. Bilateral metastatic growths developed in three patients with lesions near the tip of the tongue. The remaining ninety-nine patients had fairly well lateralized lesions (including the anterior portion of the tongue). Metastatic lesions appeared in the homolateral cervical nodes in eighty-six (86.9 per cent) of the ninety-nine patients, contralaterally in four (4.0 per cent), and bilaterally in nine (9.1 per cent). They

TABLE III

CANCER OF THE TONGUE: REPORTED SERIES OF CASES

Author	Years Covered	No. of Cases	Factors of Selection	Site of Tumor		Predominant Treatment		Five-year Survival Rate (%)	
				Anterior	Base	Primary Lesion	Neck	Determinate*	Absolute†
Breed [4]	1933–1951	Total 100, determinate* 81	All patients seen	Yes	Yes	Radiation	Radiation	30.9	25.0
Marchetta and Mattick [12]	1937–1944	Total 270, treated 247	All patients treated	Yes	Yes	Radiation	Radiation	17.0 (anterior part of tongue 19.2)	....
Cade and Lee [5]	1925–1955	Total 653, eligible 518	Unselected	Yes	Yes	Radiation	Surgery or radiation	27	24
Martin et al. [15]	1927–1934	Treated 556	Unselected	Yes	Yes	Radiation	Radiation	25	22.3
Elkins [6]	1930–1944	98	Unselected	Yes	Yes	Radiation	Surgery or radiation	25	24.5
Wilson and Brizzolara [23]	Not stated	54	Unselected	Yes	Yes	Radiation	Dissection of neck	28	....
New [17]	Prior to 1930	Operated upon 162, traced 156	Surgical cases only	Yes	No	Electrosurgery	Dissection of neck	37.2	....
Sharp et al. [20]	1932–1944	Total 84, consecutive 41	Unselected	Yes	Yes	Radiation	Dissection of neck	....	$^{15}/_{41}$ (36.6%)
Gibbel et al. [9]	1931–1946	330	Unselected	Yes	Yes	Surgery and/or radiation	Dissection of neck or radiation	14.2	....
Ash and Millar [1]	1929–1949	Eligible 394	Presumably unselected	Yes	Presumably	Radiation	Surgery	31.7	27.2
Kremen [10]	1948–1956	Total 32	Selected	Yes	No	*En bloc* surgery	*En bloc* surgery	....	$^{7}/_{10}$‡ (70%)
Wawro and Babcock [22]	1931–1952	128	Unselected	Yes	Yes	Radiation and surgery	Surgery	....	22
Lyall and Schetlin [11]	1933–1945	76	Unselected	Yes	Not stated	Surgery or electrocoagulation	Bilateral dissection of neck	....	38.1
Shedd et al. [21]	1941–1955	91, eligible 54	Unselected	Yes	Yes	Radiation and surgery	Dissection of neck	....	$^{11}/_{54}$ (20.4%)
Martin [13]	1936–1948	94	Unselected	Yes	Presumably	Radiation	Radiation	36.5	31.9
Baud [2]	1919–1941	1055	Unselected	Yes	Yes	Radiation	Radiation or surgery	....	17.2
		742	Unselected	Yes	No	Radiation	Radiation or surgery	....	20.4
Berven [3]	1931–1942	Total 302, determinate 242	Unselected	Yes	Yes	Radiation	Dissection of neck	31	24.8
Windeyer [24]	1931–1942	Total 144, determinate 135	Unselected	Yes	No	Radiation	Surgery and radiation	29.6	....
Perzik et al. [18]	1940–1955	140	Tongue and floor of mouth	Yes	Presumably	Surgery and radiation	Dissection of neck	22	13
Authors	1945–1954	269	Anterior part of tongue	Yes	No	Electrocoagulation and surgery	Dissection of neck	46.2 (traced patients)	....

* Determinate = No. of patients who survived compared to total number traced.
† Absolute = No. of patients who survived compared to total number seen or treated; untraced patients were considered failures in this group.
‡ Three-year rate = $^{15}/_{23}$ (65.2 per cent).

appeared homolaterally first in five of the nine, and bilaterally at about the same time in four.

Survival. Survival data are given in Table II. As is seen, the five-year survival rate is 46.2 per cent and the three-year survival rate is 54.1 per cent.

We attempted to evaluate the various methods of treatment on the basis of survival of patients, taking into consideration the extent and severity of the lesion. Estimation of the merit of each method was very difficult, because of the differing methods used to treat both the primary lesion and the region of the cervical lymphatics. More than one measure had been used initially in many cases, for example removal of the primary lesion of the tongue and implantation of radon seeds in the base of the wound. Even though the total group is large and fairly homogeneous, the number in each treatment group is considerably less. As would be expected, the small lesions that were removed simply by excision or electrocoagulation and never required any treatment of the neck had an excellent prognosis. In contrast, the lesions that were very extensive when first seen and were treated by radiation had a considerably poorer prognosis. If the extent of both the local lesion and the metastatic lesions of the neck is considered, the patients who underwent block cervical dissection, followed by electrosurgical removal of the primary lesion, had perhaps a somewhat poorer prognosis than did those patients in whom the primary lesion was treated first, followed by block dissection later, or those who were treated by a composite operation. In the last group (composite operation) the number was small. There did not appear to be any significant difference in survival rate between the patients treated by removal of the primary lesion and block dissection of the neck, and the patients treated by a composite operation.

Of the most significance was the five-year survival rate of 46.2 per cent. As stated previously, this rate is based on all patients with histologically proved lesions who received any form of treatment at the clinic. This survival rate compares favorably with those of other reported series of cancer of the tongue. Some survival data from reported series of cases are given in Table III. Of importance in comparing cure rates from different institutions are the factors that govern selection of cases for inclusion in the study, as emphasized by Morfit. Many of the reported series of cancer of the tongue include lesions of the base of the tongue, this being especially true of institutions using radiation methods primarily. The extremely poor prognosis for carcinoma of the base of the tongue is well recognized. Therefore, this point must receive due consideration when survival data for patients with lesions of the anterior part of the tongue only, as in this report, are compared with survival data for patients with lesions representative of the whole tongue. Similarly, one must consider the years over which the treatment took place. Treatment can be truly evaluated only when large series of unselected patients treated by fairly uniform methods are used for comparison.

COMMENTS

Many authors have advocated extended radical operations for intraoral cancers in the past decade. These composite operations have included removal of all or part of the mandible in very extensive disease. In less extensive disease the local oral growth and the homolateral cervical lymphatics have been removed in continuity, the mandible being left intact. Most of these more extensive procedures have been carried out fairly recently, and only preliminary survival data are as yet available. So far, the results in only a few selected series of patients treated by these methods have been reported. The preliminary report by Kremen, who used an *en bloc* operation for selected cancers of the anterior part of the tongue, is very encouraging. The relatively poor five-year survival rate (22 per cent) reported by Perzik and co-workers for patients treated by a "commando" operation likely represents the application of it to patients with very extensive tumors. Although these radical procedures probably have merit, their ultimate value in increasing the survival of a large series of patients remains yet to be proved.

During the period represented by the present study the great majority of our patients were treated by excision or electrocoagulation of the primary lesion and by some type of block dissection of the neck for handling the cervical lymphatics. Treatment in some cases was supplemented by the interstitial use of radium or radon seeds in the surgical wound in the tongue. Relatively few composite operations were employed during this period. In many of the patients treated by electrosurgical removal, block dissection of the cervical lymphatics and ligation of the external carotid artery prceeded

treatment of the primary lesion. Perhaps the prognosis in this group of patients was somewhat poorer than in the remaining group.

Morfit recently discussed the controversy regarding prophylactic dissection of the neck for oral cancer. Although Martin and coworkers [*14*] do not favor such dissection for occult metastatic lesions from the tongue, we believe that prophylactic dissection, used on an individual basis, is of value. The yield of metastatically involved cervical nodes in clinically uninvolved necks was 15 per cent in our series. We believe that block dissection of the cervical nodes in the absence of clinically involved nodes is worthwhile if well lateralized lesions are selected as the basis for such dissection. In well lateralized lesions the metastasis was first evident contralaterally in only 4.0 per cent of cases. Lyall and Schetlin found that no crossed metastasis was seen early in the course of the disease unless the homolateral nodes were involved. This low incidence of crossed metastasis in well lateralized lesions lends support to the principle of prophylactic dissection of the neck. With lesions near the midline or on the tip of the tongue, the pathway of metastasis is less predictable, and the problem of treatment of occult metastatic lesions of the neck becomes more difficult. For lesions in or near the midline, observation of the patient for the development of cervical metastasis is probably preferable to bilateral block dissection.

SUMMARY

A study of the data on all patients (269 cases) with squamous cell carcinoma of the anterior part of the tongue treated in any manner at the Mayo Clinic in the years 1945 to 1954, inclusive, disclosed little difference in survival among the various treatment groups when the extent of the local and the metastatic lesions was considered. Such difference as was observed appeared to favor wide local excision or hemiglossectomy plus removal of the homolateral cervical lymphatics, as either a composite or a separate procedure. The five-year survival rate for the entire series was 46.2 per cent.

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Osteoarthritis of the Spine

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ARTHRITIS is a generally abused term applied to a variety of conditions affecting the spine. The notion persists that a bony spur at the edge of a vertebral body denotes osteoarthritis. By definition this is untrue. True osteoarthritis occurs only in a diarthrodial joint. This is found in the spine posteriorly between the facets (apophyseal) [*1*]. The primary lesion in osteoarthritis is always in the hyaline cartilage; subsequently, synovial membrane and joint capsule are involved. The disk joint between vertebral bodies is classified as an amphiarthrosis. The phenomenon of spurring at this site is associated with tearing of the annulus of soft tissue at its attachment to bone, with hemorrhage and resultant ossification. Thus spurring of vertebral body margins cannot be termed arthritis either by definition or by pathology [*2*].

METHOD OF STUDY

A study was undertaken in order to determine what relationships might exist between the presence of spurs on vertebral bodies, thinning of the intervertebral disk and osteoarthritic changes in the apophyseal (posterior) joints of the spine. At autopsy, fifty-four subjects were examined grossly, radiographically and histologically. A block section was taken of the left half of the fourth and fifth lumbar vertebrae including the bodies, intervertebral disk, laminas and apophyseal joint. All findings were graded according to Fisher's classification [*3*]. Grade I: Destruction of superficial cartilage is confined to areas of greatest pressure and movement with normal capsule, synovial membrane and articular contour. Grade II: More extensive destruction of cartilage is found but still confined to pressure and movement areas. Early marginal hyperplasia is revealed by beading or ridging along the edges of the surfaces most affected by destruction of cartilage. Grade III: Total loss of cartilage results in eburnation of bone. Osteophytes form at joint margins and the contour of articular surfaces changes. The capsule undergoes fibrosis. Grade IV: With complete loss of cartilage from the joint surface, the exposed bone is eburnated and its contour remodeled. Fibrosis of capsule and synovial membrane is extensive in these cases.

In this study the ages ranged from twelve to eighty-six years. There were thirty-two males and twenty-two females. The causes of death were primarily from heart disease, malignancies and pneumonia. Pain in the back was not a factor prior to time of death. In six cases there was no spinal osteoarthritis seen grossly. The remaining were classified as Grade I, twenty-five cases; Grade II, twelve cases; Grade III, eight cases; and Grade IV, three cases. No osteoarthritis was found in subjects aged at time of death 12, 30, 32, 41, 59 and 62 years; Grade I stage was found in subjects aged 39, 42, 45, 46, 52, 57, 57, 60, 60, 60, 62, 64, 64, 66, 67, 68, 68, 71, 72, 73, 73, 73, 74, 74, and 76 years; Grade II stage was found in subjects aged 51, 54, 58, 62, 62, 62, 65, 67, 71, 73, 85 and 85 years; subjects with Grade III osteoarthritis were 58, 58, 68, 69, 72, 74, 77 and 78 years of age and those with the Grade IV stage were 65, 80 and 86 years of age at time of death.

The abnormalities looked for were osteoarthritis, thinning of the disk and spurring of the vertebral bodies, and comparisons were made. Normal intervertebral thickness of the disk was present in the six cases in which there was no osteoarthritis. In one subject the vertebral body had a large spur. In the Grade I cases three subjects had mild thinning of the disk; mild spurring was seen in nine cases and moderate spurring in three. Of the Grade II

cases, three subjects showed moderate thinning of the disk; spurring was absent in three cases, mild spurring was seen in three, moderate spurring in four and marked spurring in two cases. Two of eight with Grade III osteoarthritis had thinning of the disk; spurring was not seen in three, was found to be mild in two, moderate in one and marked in two cases. In the three cases of Grade IV osteoarthritis normal disk thickness was found in two subjects and mild thinning in one; there was no spurring in one case, mild spurring in a second and marked spurring in the third.

COMMENTS AND CONCLUSIONS

The lumbar spines of fifty-four subjects at postmortem examination were analyzed to determine the relationship between the presence of osteophytes on the vertebral bodies, thinning of the intervertebral disk and osteoarthritis of the posterior apophyseal joint. The changes in each of the three anatomical sites were independent of the other two and developed from different causes.

From this study it is concluded that osteophytes on the vertebral bodies are not evidence of spinal arthritis.

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Indications for and Application of Debricin Ficus Protease

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DURING the past seven years a number of proteolytic enzymes have been introduced for the débridement of necrotic tissues [1–4]. These agents have proved useful in varying degrees in the atraumatic and, in most instances, non-toxic removal of necrotic debris from surgical lesions.

We have evaluated the proteolytic activity of a number of enzyme preparations including streptokinase-streptodornase, trypsin, papain-urea [5], and most recently a modified concentrate of ficus latex known as Debricin®* ficus protease [6].

This material is a highly specific lytic agent for denatured collagen which will not affect partially denatured or intact living tissue. Thus, it is an excellent agent for the débridement of various types of vascular ulcers, second and third degree burns and similar lesions when it is desirable to remove devitalized material promptly without adversely affecting the surrounding normal tissues.

Specifically, Debricin is a lyophilized protease extracted from the latex of a variety of fig tree. It is a light tan, stable powder which is readily miscible in the sterile buffered vegetable gum base provided [7]. This buffered jelly base facilitates application to curved surfaces and various wound irregularities. For purposes of irrigation the reconstituted enzyme may be further diluted with suitable amounts of 0.1 molar citrate buffer having a pH of 5.0, or with saline.

The exact mechanism of the enzyme's proteolytic action is not clearly understood, but apparently certain polypeptide bonds found in denatured proteins of collagen are readily dissolved. It can also cause rapid dissolution of a fibrin clot and liquefy collections of purulent exudates. To date there have been no reported studies on the variation of polypeptides in various denatured skin tissues. We only know that a dried eschar over a deep burn requires a longer period of enzyme exposure than one that is moist and hydrated, and that the dry eschar over a decubitus ulcer or diabetic lesion of the foot is very resistant. On the other hand, the necrotic elements in a wet infected postoperative wound are very susceptible to enzymatic proteolysis.

From a laboratory standpoint the tests used for evaluation of the activity of enzymes include the immersion of a weighted spun collagen thread or a catgut suture in the enzyme solution. The breaking time is readily reproducible if the temperature and pH are kept constant. Similarly, blocks of heat-denatured human skin immersed in enzyme solution will undergo rapid eighteen-hour lysis [8]

TOXICITY

Debricin has demonstrated no local or systemic toxic manifestations from absorption when used on large open wounds involving from 30 to 40 per cent of the body surface, nor has it shown any irritation to the surrounding normal skin. When the enzyme is used on an ischemic type of ulcer it has been noted that the wound may appear slightly larger for a day or two, but this is due to the enzyme's removal of a peripheral border of devitalized tissue elements.

The only adverse reaction observed has been a transient burning or stinging sensation in some cases when the enzyme has been applied to partially epithelized surfaces, but there have

*Supplied by Johnson & Johnson, Department of Clinical Research, New Brunswick, New Jersey.

been no adverse effects on cell proliferation. On lesions of this type the difficulty may be completely obviated by using the enzyme in diluted form. Occasionally, when the enzyme is used on granulating wounds, the tissue will become friable due to enzymatic effects on the devitalized heaped-up granulations and mild bleeding may occur. This situation may be viewed as an indication that therapeutic procrastination has prevailed, since the wound should be skin grafted before this occurs.

SELECTION OF WOUNDS

To attain the highest degree of effective use, careful selection of wounds to be treated is necessary as well as scrupulous attention to details of application of the enzyme and careful timing in the matter of skin grafting (if this is to be performed).

Since enzymes are fairly specific in activity, the nature of the predominant substrate to be attacked must be known before an enzyme is selected.

In necrotic skin lesions the primary substrate is denatured collagen. In deep skin burns or slowly necrotizing skin lesions due to progressive ischemia, the collagenous substrate has undergone varying degrees of denaturation. This can materially reduce the effectiveness of the enzymatic lytic reaction, since proteolytic agents, to prevent the lysis of surrounding undenatured collagen in normal tissues, are effective principally on advanced denatured collagen.

An infected ulcerated wound with a granulation tissue base contains both fibrin and exudate. The débriding enzyme used here must be capable also of fibrinolysis. Bacteria proliferating in the wound will decrease with the removal of the necrotic elements, but bactericidal effects cannot be expected from the activity of the enzyme alone.

In deep wounds containing an abundance of fatty subcutaneous tissue, the average proteolytic enzyme will have little or no effect. However, the fascia covering the muscular elements, tendons and ligaments are primarily collagen and, if devitalized, are subject to proteolytic enzyme activity.

There exists a wide variety of surgical wounds that will respond rapidly to proteolytic enzyme débridement. These include second and third degree burns, various types of ulcerations, including the common peripheral stasis ulcers, gangrenous small parts of the extremities, sinus tract fistulas, abscesses, empyemic cavities, wound infections and pyodermas.

TREATMENT OF WOUNDS

Enzymatic débridement is an excellent tool when properly used, although it must be viewed as a supplement to good surgical technics. Careful wound dressing technics under aseptic conditions, along with the use of parenteral antibiotics, are essential to assure the best results.

Evaluation of appropriate enzyme-antibiotic combinations for local control of propagating bacteria is now in progress, but it is already known as the result of the work of Grutter et al. [9] that Debricin ficus protease is compatible with neomycin, bacitracin, chloramphenicol and penicillin, in that both the antibiotics and the enzyme retain full activity for twenty-four hours at 37°C. Polymyxin B, tetracycline, chlortetracycline, oxytetracycline and erythromycin are incompatible with Debricin. Since our clinical observations indicate that the removal of necrotic tissues decreases bacterial growth, the addition of an antibiotic may aid in further decreasing the wound's bacterial flora.

To achieve effective proteolytic enzyme débridement, the following conditions must be met:

1. The enzyme selected must be capable of lysing the predominant necrotic substrate.

2. The application of enzyme to substrate must be of maximum duration for rapid lytic activity. In many wounds this may be difficult to obtain, but nevertheless maximum contact is essential.

3. The enzyme-substrate reaction must be carried out in an optimal pH, which makes a buffering system necessary. Debricin is supplied with its own buffering system.

4. The accumulation of lytic by-products must be periodically removed. In wet exudative wounds the dressings should be changed frequently, i.e., every six to twelve hours, whereas the dry wound may be dressed less often.

5. It is very important *not* to wash the part to which the enzyme is to be applied with agents containing hexachlorophene or chemically related compounds since the activity of the enzyme is thereby inhibited. Instead, any nonirritating plain detergent, mild soap or saline may be used.

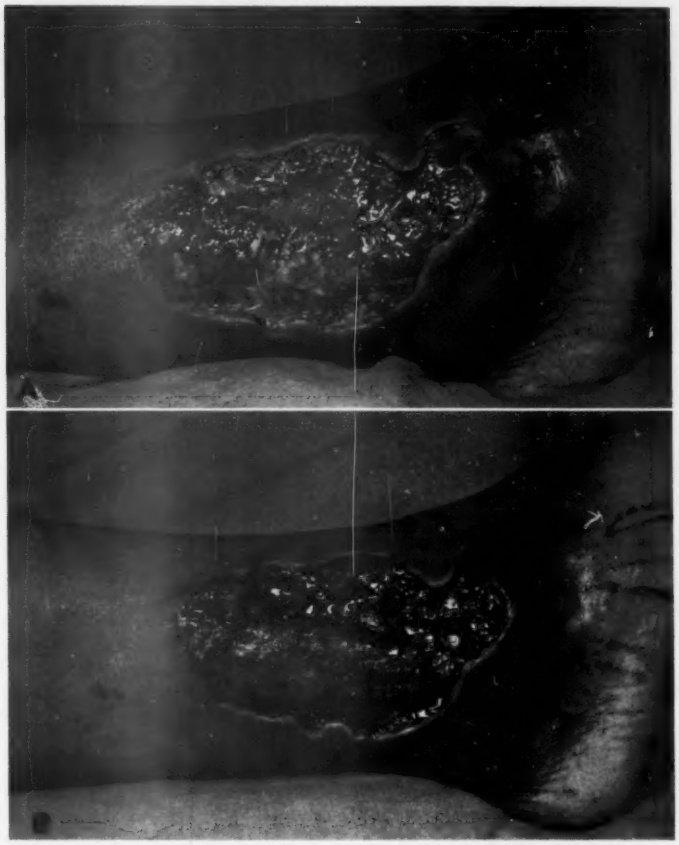

FIG. 1. A, large infected stasis ulcer of leg of many months' duration. B, ulcer ready for skin graft after thirty-six hours of Debricin therapy.

Following are some specific suggestions for treatment of some of the wounds suitable for enzymatic débridement:

The *ulcerated lesions* (Fig. 1) found in patients with varicose veins, decubitus ulcers, arterial ischemia and unhealed burn wounds consist of infected granulation tissue on a chronic inflammatory base. The surrounding epithelial elements are heaped up and are sensitive to minor trauma. Portions of exposed fascia or tendon sheath undergoing slow necrosis may be found in the wound, which will also contain an exudate consisting of small necrotic tissue elements, fibrin and bacteria. The time-honored application of wet saline soaks under moderate pressure will, by dilution, decrease these elements to a certain extent, but each change of dressing, unless carefully carried out, provokes fresh irritation and delays healing. In the case of even simple ulcers it may take eight to ten days to prepare for skin grafting with this method, while a deep ulcer with necrotic fascia may require several weeks of such therapy.

However, when simple stasis ulcers with adequate blood supply to the surrounding tissues are treated by daily applications of about 1.0 per cent saline dilutions of the jelly preparation of Debricin ficus protease or the various trypsin, fibrinuclease, papain or streptokinase-streptodornase preparations in full strength, rapid cleaning is obtained in forty-eight hours and the wound is made ready quickly for immediate grafting when this is required. On simple lesions of this type a 1.0 per cent dilution of Debricin is suggested, since the very marked activity of the 7.5 per cent

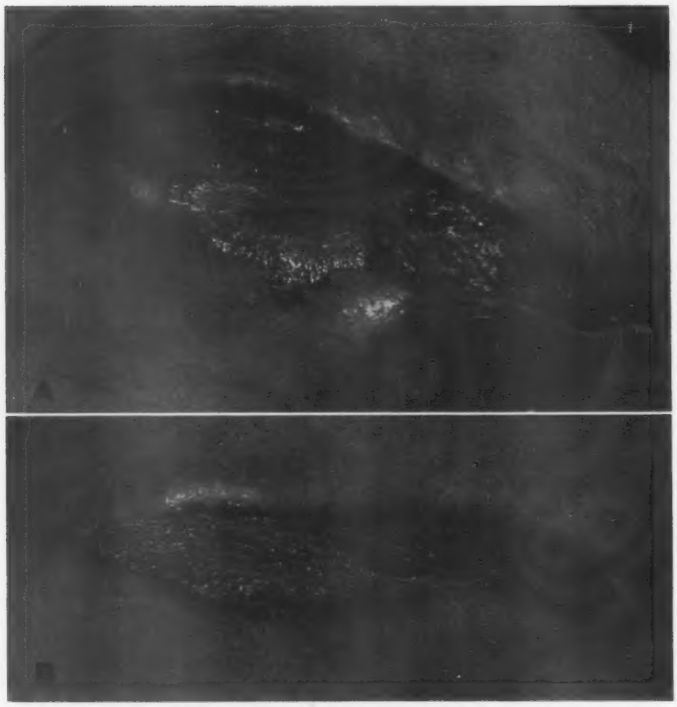

FIG. 2. A, large abscess of posterior thorax drained four days previously and under daily Debricin applications for three days. B, abscess cavity almost completely healed after fourteen days of enzyme therapy. Note healthy granulation tissues with minimal infection.

concentration of the enzyme as supplied is not required to lyse the fibropurulent exudate characteristic of such lesions and may cause some burning or irritation due to the superficial trauma already present in the surrounding areas. Means of making such a dilution are found on page 689. We have been informed that within the near future a dosage form will be available which will yield a 1.0 per cent concentration of the active enzyme immediately upon restoration.

In deep ulceration, as in decubitus ulcers or those due to diabetic gangrene, only ficus protease or, to a lesser extent, papain have the capacity to act on the necrotic fascial elements.

The dressing technic recommended for the deep ulceration consists of first unroofing the dry eschar of the ulcer, if present, and then applying the enzyme twice daily, in its buffered jelly base, under a double layer of impregnated rayon gauze and an occlusive dressing roll to secure the enzyme in place. The doubled non-adherent dressing is utilized for two reasons: (1) is is non-traumatic even when used for frequent dressings, and (2) it helps to keep the enzyme puddled over the substrate tissues to be removed. In most instances Debricin ficus protease will clean the wound in five to ten days, whereas the papain preparations available will require one to three weeks. Skin grafting should be performed as rapidly as possible once the wound is clean.

Infected wounds, fistulas and sinus tracts closely approximate *in vitro* conditions, in that the enzyme is applied to a confining trough, tube or bottle-like structure. A maximum degree of enzyme-substrate contact is thereby assured, but changes in the fluid media are required every eight to ten hours to reduce the effect of by-product accumulation. These breakdown products can appreciably affect further lysis as the result of dilution and pH changes. Also, further bacterial proliferation may occur during this period, as the conditions for bac-

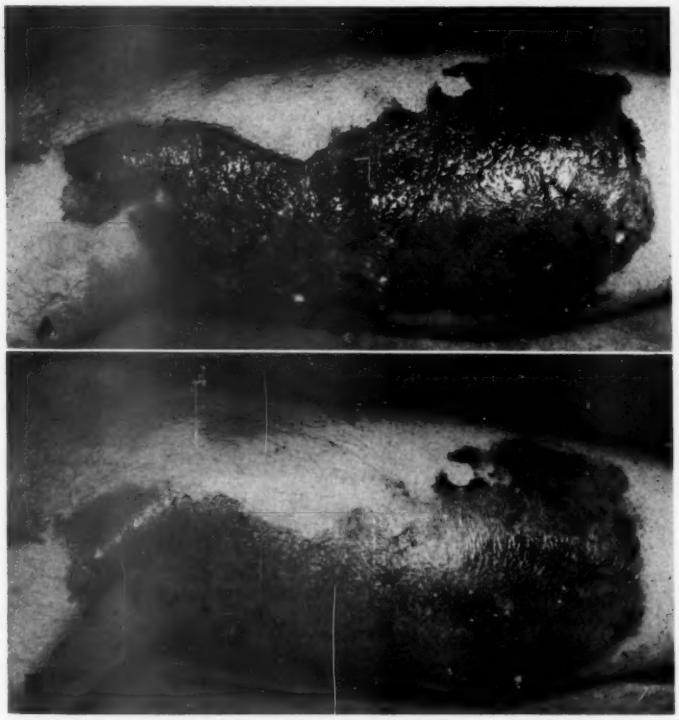

FIG. 3. A, second degree burn treated by open therapy four days after injury. Substrate is thick crust. B, after four days of Debricin therapy wound has completely epithelized.

terial growth are optimal and these additional bacteria may have an added inhibitory action on the enzyme.

These wounds contain fibrin exudate, necrotic fascia and granulation tissue which are most quickly and atraumatically removed by the use of ficus protease. If fascial elements are involved, the other enzymes are generally slower or even ineffective in achieving the desired results. In large, circumferential or sinus tract wounds, Debricin may be instilled through a multiperforated catheter which has been wrapped in gauze and laid on or in the wound, the whole then being covered with a single layer of non-adherent wound dressing. The catheter is irrigated with a 3.0 per cent enzyme solution every three hours, in sufficient volume to keep the undersurface of the gauze saturated.*

In this type of dressing the accumulated by-products of the reaction are constantly diluted and absorbed into the dressing. While this type of dressing may remain in place longer than others described, it should be changed every forty-eight to seventy-two hours.

Large abscesses and empyemic cavities (Fig. 2) should be irrigated with a 3.0 per cent saline solution of the enzyme and the residual solution left in place for six to eight hours. During the first forty-eight hours one will note an initial increase in the purulent exudate. Thereafter, the amount of exudate at each dressing will become less until traces of blood are noted in the discharge. This bloody discharge indicates that there is active filling of the cavity. Enzyme applications then may be volumetrically reduced and the interval between irrigations lengthened to twenty-four hours. Only

* A dilute solution may be made by dissolving one 5.0 gm. packet of Debricin enzyme in its buffered jelly base, and slowly adding 100 cc. of normal saline to the enzyme mixture while stirring constantly to prevent curdling. To produce a 1.0 per cent solution, 300 cc. of saline are added.

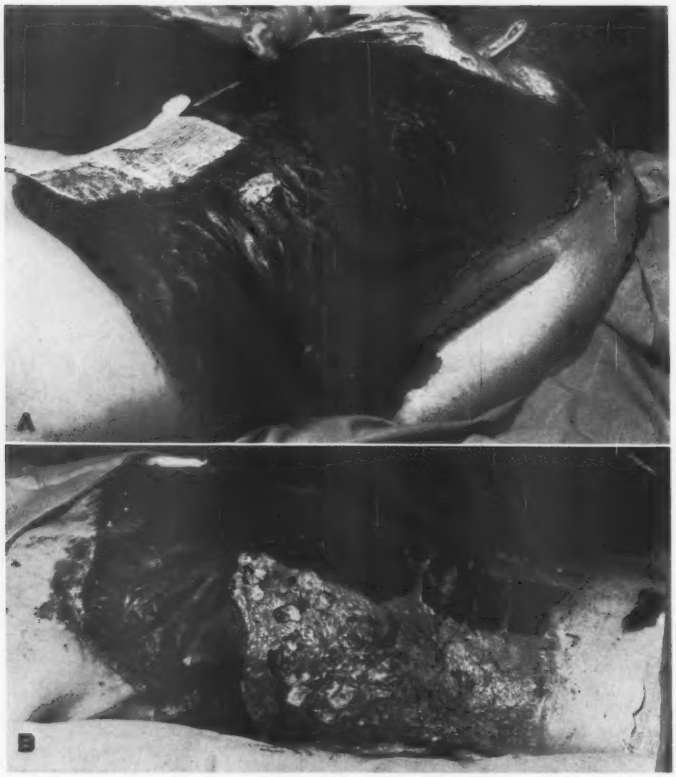

FIG. 4. A, third degree burn treated by open therapy seven days after injury. Substrate is thick denatured collagenous eschar. B, segmental Debricin débridement of a portion of eschar after seven days of enzyme therapy. Skin grafts are in process of being placed.

empyema which has become thoroughly localized and walled off should be treated by this method in order to avoid the possibility of pleuritic absorption.

The *second degree burn wound* (Fig. 3) is predominantly an injury to the deep epidermis. The devitalized cells blister off rapidly, leaving a partially devitalized cellular base which becomes covered with a thick fibrinous coagulum. This coagulum is readily removed on the third or fourth day after injury by a wet dressing consisting of a 3.0 per cent saline solution of the resorted ficus protease. The undiluted buffered jelly base containing the enzyme may be used also; usually only three twelve-hour applications are necessary.

The second degree burn involves not only the deep epidermis but also portions of the dermis, and constituents of this surface substrate are both cellular coagulum and denatured collagen. This is often very resistant to lysis for only a portion of the involved derma is devitalized and the remainder may not have epithelial nests. The coagulum is removed readily enough, as are the completely devitalized collagen areas, but where the collagenous portions are only partially necrotized the enzyme will only soften the substrate. In most instances ten to fourteen days are required for complete separation of this partially devitalized area.

Small burns will often heal spontaneously as long as infection is prevented. In large burns we have occasionally carefully excised the partially devitalized eschar. If this is done judiciously, after the completely devitalized material has been removed by the enzyme, skin

grafting may not be needed. However, in many instances we convert the wound to a full skin loss and grafting must be performed.

The technic of enzyme débridement of the second degree burn wound is to apply the buffered enzyme in jelly base or as a saline dressing twice a day. After seventy-two hours the wound will be débrided of all necrotic tissue elements and the remaining derma is then dressed once daily for four to five days. At this point the patient may complain of burning sensations over the healthy but incompletely epithelized areas surrounding the unseparated dermal substrates. We have found that either the careful application of the enzyme to only those areas to be débrided, as a light application of the jelly, or dilution to a concentration of 3.0 per cent to 1.5 per cent by the addition of more normal saline will enable the patient to continue the treatment without discomfort.

After a four- to five-day period it is possible to judge whether or not the partially devitalized area will separate. If the areas are large, the patient is brought to surgery and under anesthesia the adherent areas are carefully dissected. The wound is dressed with the enzyme in the buffered jelly base, and is covered with a single layer of non-adherent dressing. After four days the wound is again inspected. If the area is largely composed of granulation tissue, skin grafting is performed. If there are large numbers of epithelial islands with little or no infection, the wound should heal *per primam*.

The *third degree burn* (Fig. 4) is composed of a completely denatured collagen with all epidermal elements destroyed, and damage may extend in depth to include subcutaneous fat tissue, fascia, tendons and muscle.

In this type of wound the extent of the body surface burned must be taken into consideration. If the area is 10 to 12 per cent of the body area or smaller, we have utilized immediate excision and skin grafting. In wounds in difficult areas, and those involving up to 20 to 30 per cent of the body, we apply the enzyme either as a buffered jelly, a wet dressing or by irrigation through a catheter. It has been found that if treatment is started on the day of admission to the hospital with dressings changed twice daily, the average wound will be ready for skin grafting in five to seven days.

In the extensive third degree burn involving more than 25 to 30 per cent of the body surface, treatment is delayed until the third or fourth day, or until the patient is physiologically stabilized. We then use the enzyme to débride no more than a 20 per cent portion of the eschar at a time, starting with those areas most vulnerable to contracture, such as hands, wrists, elbows, axillas, knees and feet. The reason for this is principally to have sufficient skin available at any one time for adequate grafting.

In any infected burn wound a parenteral broad-spectrum antibiotic should be used in conjunction with the enzyme. In such wounds the breakdown of the necrotic substrate by the enzyme in the presence of bacteria, body heat and a dressing will resemble an abscess with profuse drainage. Dressings should be changed twice daily and catheter irrigation used to provide constant drainage.

As soon as the surface of the third degree burn is débrided, the wound can be covered with a split-thickness skin graft, either as a perforated sheet or as postage stamp grafts.

RESULTS

The studies leading to the findings discussed herein were carried out in the laboratories and wards of the Surgical Service of St. Vincent's Hospital in New York City. To date, Debricin ficus protease has been used in over 135 patients with various surgical lesions. The results, which for the most part have been gratifying, have been given in a previous report [6]. There were no local or systemic toxic manifestations.

SUMMARY

In this paper we have attempted to describe in detail technics of use of a new proteolytic enzyme, Debricin ficus protease, including proper wound selection and management. Our results to date in 135 patients indicate that this proteolytic enzyme is effective if used on the proper substrate in a correct manner, and in many instances represents a marked economic saving to the patient in terms of hospital time and operative procedures required. Physiologically it often offers the important advantage of shortening the time required to prepare the patient for skin grafting.

The use of enzymatic agents for débridement does not replace standard surgical technics, but gives the surgeon an additional tool in his armamentarium.

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A Simplified Chart for Estimating Burn Areas

JOHN A. SAKSON, M.D., *Camden, New Jersey*

WITH the ever-increasing knowledge of therapy in the treatment of burns, it becomes evident that accuracy in estimating the total surface area of a burn is mandatory. Marked discrepancies are usually found between the estimates made in the Emergency Room and

THE COOPER HOSPITAL
CAMDEN 3, NEW JERSEY

Name of Patient _____

Age _____ Sex _____

BURN ESTIMATION CHART

Outline Burn Areas on Figures:
1. Erythema (1°) ////// (lines)
2. Blebs (2°) ###### (cr. hatch)
3. Charring (3°) ■■■■■ (solid)

PLEASE: Try to make accurate estimates

Body surface area percentages from Lund and Browder

AGE	BIRTH	1	5	10	15	ADT.
Head	19%	17	13	11	9	7
Neck	2%	- - -	- - -	- - -	- - -	- - -
Ant. Trunk	13%	- - -	- - -	- - -	- - -	- - -
Post Trunk	13%	- - -	- - -	- - -	- - -	- - -
Buttocks	5%	- - -	- - -	- - -	- - -	- - -
Genitalia	1%	- - -	- - -	- - -	- - -	- - -
Upper Arms	8%	- - -	- - -	- - -	- - -	- - -
Forearms	6%	- - -	- - -	- - -	- - -	- - -
Hands	5%	- - -	- - -	- - -	- - -	- - -
Thighs	11%	13	16	17	18	19
Legs	10%	10	11	12	13	14
Feet	7%	- - -	- - -	- - -	- - -	- - -

Front

Back

Time of Burn _____ A.M. / P.M.

Time of Admission to ED _____

Cause of Burn _____

Weight of Patient _____ lbs. _____ kgs.
(1 lb. — 0.45 kg.) (1 kg. — 2.2 lbs.)

Admission BP _____ Pulse _____

Condition of Patient _____

Fluids started at _____ A.M. / P.M.

TYPE and AMT.	I. V.	CUTDOWN	ORAL

FLUID LOSS

Emesis: _____
Urine: _____
Other: _____

Area of Front _____ % Area of Back _____ %

TOTAL BURN AREA _____ %

Tracheostomy _____ A.M. / P.M.

Catheter _____ A.M. / P.M.

Medication _____

Type of Dressing _____

Disposition _____

Final Bp _____ Pulse _____

Status _____

Name of Doctor _____

82/200

FIG. 1.

the actual extent of the burn as noted at the first change of dressings. These figures are often in variance by as much as 20 per cent and usually about 5 per cent. It is a well nigh impossible task to evaluate a burn after the patient has taken on the appearance of a "vaselinized mummy." To reduce the inherent errors to a minimum, this chart has been devised. (See Fig. 1 on page 693.)

Upon admission of the patient to the Emergency Department, most information regarding the time of the burn's occurrence and its cause is available from relatives or police. The burned area is in full view for an immediate examination and its extent can be depicted quickly and accurately. All emergency treatment may be noted as it is administered. Before final disposition of the patient is made, the area of the burn according to per cent is totaled (Lund and Browder's percentage table is used since it has been found to be the most consistently reliable method for all ages). Only the absolutely essential information is required in order to keep the chart simple and eliminate unnecessary "paper work." The clear space in the upper left hand corner is used for ward stamping of information regarding the patient.

It is believed that this chart gives ward personnel a complete and graphic record of the status on admission and emergency treatment of a burned patient for use in determining further therapy. An accurate first hand picture is available providing a fixed reference point. Medicolegally, this is important since affected areas can be neither exaggerated nor minimized. The results of different therapies and grafting procedures can be readily assessed. Day to day progress can be pictorially charted.

SUMMARY

A simplified chart is presented which provides an accurate method for estimating the total surface area of a burn. It also provides a useful record and valuable guide for use in the treatment of the burned patient.

Clinical and Experimental Evaluation of Suture Materials Treated with Antibiotics

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From the Department of Surgery, Escuela Medico Militar, Mexico, D. F.

ADEQUATE care of the patient during the pre- and postoperative periods and the latest surgical technics for vascular anastomosis, open heart surgery, surgery for cancer and transplantation of tissue are characteristic of the high level of present day surgery. However, it is not enough to improve technics and medical care alone. The equipment must also be improved. We believe that the innovation of using sutures previously treated with antibiotics is an important step forward. In this paper we shall present the results obtained employing these sutures.

In order to evaluate the surgical effects obtained with sutures it is necessary to consider several factors which affect not only good scar formation, but also the development of infection in the wound (resulting in cellulitis, suture abscess or dehiscence, peritonitis, hemorrhage, mediastinitis or postoperative eventration). The disadvantages of suture materials revealed in the expulsion of stitches, defective scars or chronic fistulas must also be evaluated. Actually, a great many of these complications may be due to poor surgical technic such as the placing of sutures under tension, the presence of large knots, mass ligation, or the injudicious handling of tissue, all of which contribute to localized necrosis. Even the type of incision is important; for example, in the abdomen, vertical incisions divide a greater number of vessels and nerves, thus favoring dehiscence. Important technical details also influence surgical results, e.g., the selection of the proper type of suture required for different tissues, failure to eliminate dead spaces, insufficiently sterilized dressings or instruments, contaminated operating rooms, incorrect use of masks, contamination during the operation, inadequate drainage, neglect during the postoperative period, infection present before the operation, and perhaps most important of all, the nutritional state or the electrolyte imbalance of the patient.

In addition to the many complicating factors mentioned that affect the outcome of a surgical procedure independent of the quality of the suture employed, it would appear difficult to evaluate a new suture material since results are usually satisfactory when correct surgical technic is employed.

The majority of suture materials currently in use are suited to the various types of surgery since they combine basic qualities such as adequate tensile strength, sterility and flexibility, and are well tolerated by the tissues. Nevertheless, any attempt to improve them is commendable as the surgical field, in reality, is not completely sterile (air, particles of saliva in spite of masks, incomplete disinfection of the skin, open technic in gastrointestinal anastomosis, etc.).

For these reasons we have undertaken a short but detailed clinical and experimental study with new non-absorbable sutures treated with antibiotics. Work by Madsen [*1,2*] carried out in Denmark has been useful to us in this study. He observed the reaction to different types of sutures in numerous animals and one volunteer human subject. He used absorbable (chromic and plain) as well as non-absorbable materials, and reached the following conclusions: (1) the plain absorbable material provokes an intense tissue reaction with retarded formation of collagenous tissue, and the knots tend to loosen, causing hematomas or hemorrhage; (2) in the peritoneum, there is a greater tendency toward the formation of adhesions when plain catgut is used; (3) the

fine non-absorbable material shows a very favorable tissue reaction, with little exudation during the entire period of cicatrization and rapid formation of collagen. The knots are secure, except in the case of synthetic monofilament fibers, and maintain their tensile strength.

The previous data, decidedly in favor of non-absorbable sutures, provide an opportunity to initiate new studies when another element of safety, previous treatment with antibiotics, is added.

MATERIAL AND METHODS

The following material was used for our study: (1) Sterilized yellow braided silk, non-capillary, treated with Aureomycin,® 1.5 per cent w/w, Nos. 2-0 and 4-0 caliber with Atraumatic® needle; (2) sterilized green or yellow braided silk, non-capillary, treated with Aureomycin, 1.5 per cent w/w plus neomycin 0.5 per cent w/w, Nos. 2-0 and 4-0 caliber with Atraumatic needle; (3) sterilized yellow cotton, treated with Aureomycin 1.5 per cent w/w, Nos. 2-0 and 4-0 caliber with Atraumatic needle; and (4) control materials, not treated with antibiotics but similar in characteristics and quality to the aforementioned material. All sutures were packaged in plastic envelopes.*

Surgical procedures were performed on forty-two patients, six children and thirty-six adults, for various conditions, the majority of which were gastrointestinal.

The trial material was used throughout the procedure in the majority of the operations. In some cases of major surgery, for example in esophagectomy and abdominoperineal resection, it was used only to perform the anastomoses and to suture the peritoneum.

Incisions for laparotomy were of the transverse type. These are used routinely on our Service and have been demonstrated to be the most efficient in preventing postoperative dehiscence. Stitches placed to close the incision, as well as the anastomosis, were made with care in order not to produce great pressure or tension.

The general condition of all our patients was good, and the results of the preoperative tests were within normal limits, with the exception of two patients with diabetes and one with hypertension.

In order to appreciate better the advantage of the antibiotic in the suture material we did not, as routine procedure, administer antibiotics to any of the patients during the pre- or postoperative course; in only two cases were they necessary, for one patient with gastrectomy and severe bronchitis, and for another with hemorrhagic pancreatitis with frank peritoneal reaction. In both cases 1 gm. of tetracycline (Achromycin®) was administered daily; in the first case it was administered orally and in the second intravenously.

A sterile dressing was used over the wound during the first twenty-four-hour postoperative period, after which the wound was uncovered and left without dressing. Observation and postoperative care were routine in most cases, enabling the patients to be ambulatory in less than twenty-four hours. A diet sufficient in calories and nutritive elements was reinstated as soon as possible. During the postoperative periods we watched the results of the trial materials used for anastomosis as well as the tolerance in the wall of the incision, observing the appearance of inflammation or localized infections, expulsion of stitches, dehiscences or eventration. During the operations the characteristics of the trial materials were judged according to ease of handling, tensile strength, tendency not to knot and convenience of the green or yellow color.

In forty-two patients the surgical procedures were: esophageal diverticulectomy, one case; esophagectomy, one case; resection of varices of the esophagus, one case; gastrectomy, eight cases; gastrostomy, four cases; exploratory laparotomy, three cases; anterior resection of the rectum, one case; abdominoperineal resection, one case; inguinal hernioplasty, five cases; appendectomy, six cases; cholecystectomy, five cases; choledochotomy, two cases; suture of the pancreas, one case; resection of defective abdominal cicatrix, one case; and excision of lipomas, two cases.

RESULTS

Recovery was uneventful in all patients. In all patients the postoperative course took the usual period of time; there were no fatalities or complications with the exception of one patient in whom tracheobronchitis developed (post-gastrectomy) and another who presented paralytic ileus with great abdominal distention (operated upon for pancreatitis and vesicular gangrene).

* The sutures were graciously provided by Surgical Products Division of the American Cyanamid Company.

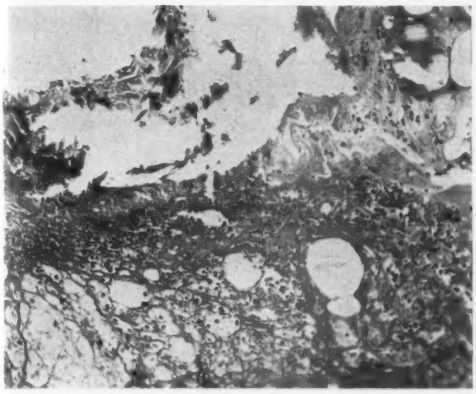

FIG. 1. Skin, seventy-two hours postoperatively. Suture prepared with antibiotic. Fibrinous exudate with few leucocytes. Slight inflammatory reaction—with fibrin organization before cicatrization.

FIG. 2. Skin, seventy-two hours postoperatively. Suture treated with antibiotic. Fibrinous and fibroblastic reaction with few leucocytes around the suture.

It must be noted that open (septic) technics were used in all gastrointestinal procedures as well as in the three cases of esophageal surgery (diverticulum, varices and esophagectomy). In four of the patients there was frank sepsis: two cases of suppurative appendicitis, one case of acute suppurative cholecystitis and one of hemorrhagic pancreatitis and vesicular gangrene. In these four cases canalization with pliant oilskin tubing was permitted.

In view of the fact that during the patients' postoperative courses it was impossible to observe the reaction of the tissues to the suture microscopically, various intestinal anastomoses were performed on three dogs. Both the anastomoses and the closures of the abdominal walls were made with sutures treated with antibiotics, as well as with trial material without antibiotics and black cotton sutures routinely used on our surgical service. The wounds were reopened, in the first animal in three days, in the second in four days, and in the third in eight days, for macroscopic examination of the sutures. Tissue was also excised and prepared in paraffin and stained with hematoxylin-eosin stain for microscopic study.

First Dog. Macroscopic findings were as follows: The peritoneum sutured with silk treated with an antibiotic showed perfect coaptation of the borders. No signs of infection or edema were observed. Very slight edema and viable intestinal transit were observed in the end-to-end anastomosis using this suture. In another anastomosis in which cotton thread not treated with antibiotics was used, edema was observed along the entire line of the anastomosis as was limited purulent secretion at some points.

Microscopic findings or specimens obtained after seventy-two hours were as follows: (1) Suturing of the skin with thread prepared with an antibiotic resulted in approximation of the borders without cicatrization. Edema, sanguineous congestion, fibrinoid exudate with polymorphonuclear leukocytes and absence of fibroblasts were noted. There was a moderate inflammatory process around the suture and an initial inflammatory period of reaction to cicatrization (Figs. 1 and 2.) After suturing of the intestine with antibiotically treated thread

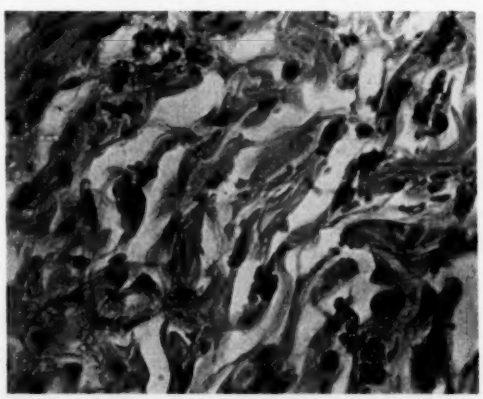

FIG. 3. Intestine, seventy-two hours postoperatively. Suture treated with antibiotic. Abundant new fibroblasts near the site of the suture. Complete absence of inflammation.

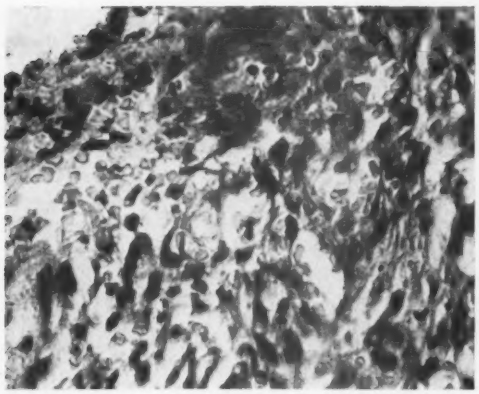

FIG. 4. Intestine, four days postoperatively. Suture treated with antibiotics. Good fibroblastic reaction surrounding the suture. Slight inflammation.

FIG. 5. Intestine, four days postoperatively. Without antibiotics. Abundant purulent fibrin exudate in the mucosa with no regeneration of the epithelium.

regeneration of the epithelium of the mucous membrane began. The granulation tissue which unites the muscular walls was loose, with a good number of fibroblasts; there was no inflammatory exudate. (Fig. 3.) (2) The difference in suturing with thread not prepared with antibiotics is to be found in the presence of more inflammatory exudate.

Second Dog. Macroscopic findings were as follows: Two anastomoses were performed, one with silk sutures treated with antibiotics, and the other with untreated silk sutures. The operation was performed through two different incisions in the abdominal wall, using the same type sutures. On the fourth day, the dog was reoperated upon with the following findings: Suturing of the wall with silk treated with antibiotics resulted in normal cicatrization; suturing of the wall with the control silk not treated with antibiotics resulted in the formation of a small subaponeurotic hematoma with signs of incipient infection. The results of the anastomosis with sutures treated with antibiotics were: Satisfactory transit, slight edema and good cicatrization. The results of the anastomosis with the control thread were: adhesions to the omentum, a limited purulent secretion, moderate edema and slight impairment of transit.

Microscopic findings on specimens obtained after four days were as follows: (1) Suturing of the skin with silk prepared with antibiotics

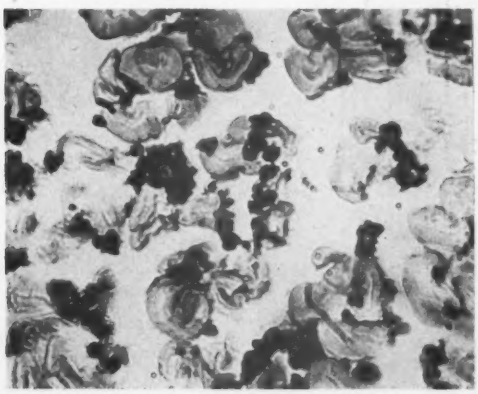

FIG. 6. Intestine, four days postoperatively. Without antibiotics. Fragments of suture with pronounced polymorphonuclear infiltration.

FIG. 7. Intestine, four days postoperatively. Without antibiotics. Pronounced inflammation at the periphery of the suture.

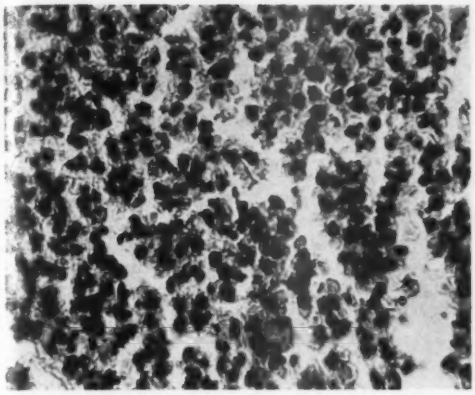

FIG. 8A. Intestine, four days postoperatively. Without antibiotics. Microabscess in the zone near the suture.

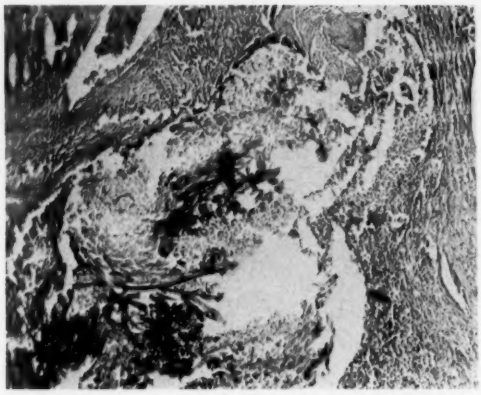

FIG. 8B. Intestine four days postoperatively. Without antibiotics. Another aspect of microabscess formation and purulent fibrin exudate at the suture site.

resulted in granulation tissue with numerous fibroblasts and no exudative inflammation. Suturing of the intestine with antibiotically treated thread resulted in regeneration of the mucosa with a moderate exudative inflammatory reaction and cicatrization of the muscular layers. (Fig. 4.) (2) Suturing of the skin with silk not prepared with antibiotics resulted in abundant inflammatory exudate in the dermis and limited production of fibroblasts. Suturing of the intestine with antibiotically untreated silk resulted in incomplete regeneration of the mucosa and abundant inflammatory exudate. Weak cicatrization of the muscular layers and purulent fibrinous inflammation which extended to the peritoneum were noted. (Figs. 5, 6, 7, 8A and 8B.)

Third Dog. Macroscopic findings were as follows: Two abdominal incisions were made; one was closed with cotton thread treated with an antibiotic and the other with the control cotton thread without an antibiotic. Three anastomoses were performed, using (1) cotton thread treated with an antibiotic, (2) cotton control thread not treated with antibiotic, and (3) black cotton thread currently used on our Service.

After eight days, the animal was reoperated upon and the following findings were noted: Good cicatrization with moderate congestion and edema in the wall where the thread treated with an antibiotic was used, and purulent secretions in three stitches in which the control thread was used. In the anastomosis performed with sutures containing antibiotics the results were: slight edema, good transit and adequate cicatrization. The results of the anastomosis with the control thread were: adhesions to the omentum, edema in the margins, purulent secretion, and a small dehiscence sealed by omentum. The results of the anastomosis with the black thread currently in use were: adhesions to other intestinal loops, and frank purulent secretion of the margins.

Microscopic findings on specimens obtained after eight days were as follows: (1) Suturing of the skin with thread prepared with antibiotics resulted in perfect cicatrization and some inflammatory foci in the dermis. (Fig. 9.) Suturing of the intestine with antibiotically treated sutures resulted in complete regeneration of the mucosa with no formation of folds.

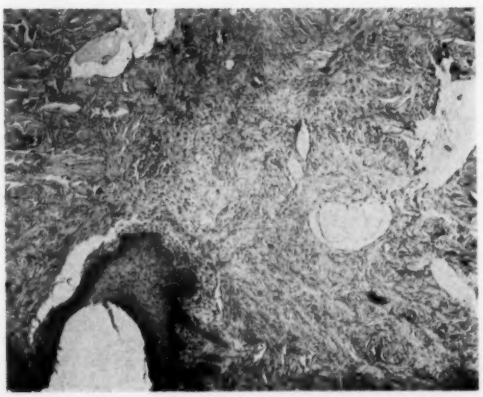

FIG. 9. Skin, eight days postoperatively. With antibiotic. Perfect epidermization. Scar with conjunctive tissue in the dermis.

FIG. 10. Intestine, eight days postoperatively. With antibiotic. Regeneration of the mucous epithelium and fibrous cicatricial tissue with no inflammation.

FIG. 11. Intestine, eight days postoperatively. With antibiotic. Manifest cicatricial zone. Abundant fibroblasts and capillary proliferation. No inflammation.

Cicatrization of the muscular layers by fibrous tissues, persistence of diffuse infiltration of polymorphonuclear leukocytes, absence of exudates in the serosa, and fibrous reaction around the sutures were noted. (Figs. 10 and 11.) (2) Suturing of the skin with thread not prepared with antibiotics resulted in cicatrization and the presence of acute exudative inflammation in the dermis. Suturing of the intestine with antibiotically untreated thread resulted in incomplete regeneration of the mucosa due to the presence of inflammatory exudates and buds of hypertrophic conjunctive tissue. Exudative inflammation in the muscular layers and an inflammatory granulation process around the suture were noted. There were also exudates in the serosa with zones of formation of conjunctive tissue (adhesions). (Figs. 12 and 13.)

*Conclusions of the Histologic Study.** Suturing with threads treated with antibiotics accelerates the cicatrization process with no active inflammation within the first four days, the inflammation being null and the cicatrization perfect at eight days.

* The histologic studies were conducted by Dr. Alfonso Acuna Torres of the Hospital Central Militar, Mexico City, Mexico.

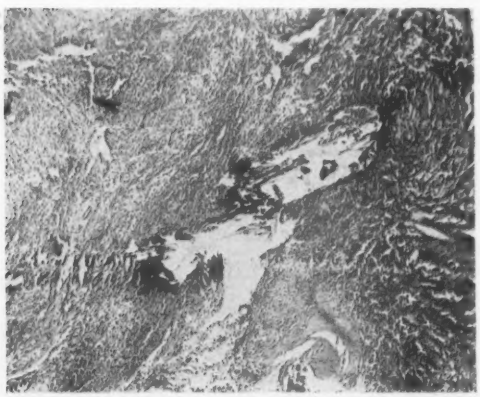

FIG. 12. Intestine, eight days postoperatively. Without antibiotic. Suture with peripheral exudative inflammation which extends to the mucous membrane where no regeneration of the epithelium is apparent.

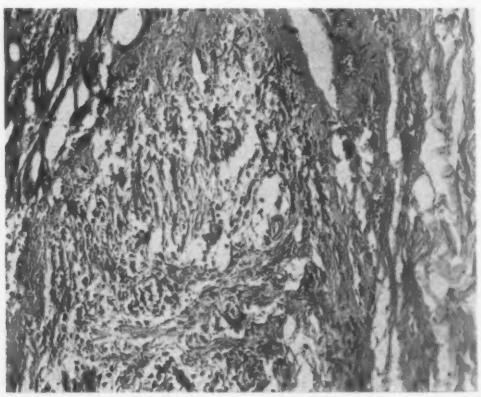

FIG. 13. Intestine, eight days postoperatively. Without antibiotic. Increased magnification. Persistence of acute inflammation of the muscular layers.

Suturing with thread not prepared with antibiotics produces excessive cicatrices, the exudative inflammation persisting for eight days. In the intestinal suture, frank peritoneal reaction with fibrinous purulent exudate and fibrous plastic reaction in the serosa were found.

From the work conducted on the human subject, as well as on animals, the following observations were made with respect to the suture material treated with antibiotics.

Tolerance: There were no signs of inflammation or expulsion of stitches in any of the subjects.

Resistance (tensile strength): Only one of the cotton threads treated with Aureomycin broke easily (more than 200 sutures were used). In all other cases and with different types of material there was perfect resistance during normal handling. It is important to note that this material evidently has greater tensile strength than that generally used on our Service (commercial cotton thread). Also, a greater resistance than that of similar calibers of catgut was observed. In no case was there dehiscence of the wound in spite of the fact that one patient had a severe cough during the postoperative course and another had paralytic ileus and marked abdominal distention (the patient with pancreatitis).

Color: The yellow material (treated with Aureomycin) and the control suture are not good with regard to color. They have the same disadvantage as white thread; the blood stains it, and it cannot be easily identified during the operation. It would be convenient if it were dyed black in order to distinguish it more easily. On becoming moist, the green material (with neomycin) offers less disadvantage in this respect because it is darker.

SUMMARY AND CONCLUSIONS

A new type of suture material made of silk and cotton previously treated with Aureomycin or with Aureomycin plus neomycin has been tested. Following conventional surgical technics (and comparing the results with the usual suture material), forty-two patients principally with gastrointestinal and esophageal illnesses underwent surgery. It was found that the conventional non-absorbable material with capillary action, by permitting the passage of tissue fluids the full length of the thread, may facilitate infection by the passage of bacteria from one tissue to another. This infection may take hold if it is not inhibited by the action of the antibiotic in the suture material. Signs of intolerance were not found in any of the patients. There were no cases of postoperative infection or dehiscence. In order to study the histologic response to this material, surgery was performed on dogs, which were then sacrificed three, four and eight days after the operation. At autopsy it was found that the sutures treated with antibiotics hasten the process of cicatrization while the sutures not prepared with antibiotics form excessive cicatrices causing a frank inflammatory exudative and fibrinous purulent reaction with abundant plastic fibrous reaction in the serosa.

From these findings we conclude that this new type of suture material treated with antibiotics is of great importance to the advancement of surgery.

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Appendicitis—Is It on the Wane?

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ACUTE appendicitis and appendectomy were more serious problems in the practice of medicine and surgery in the twenties and thirties than they are today. The death rate, complications and prolonged invalidism associated with this disease in the past certainly have changed in a favorable manner during the last eighteen years. These favorable changes have been due to the many advances which have occurred in medicine and surgery during and since World War II.

Current evidence in some localities indicates a definite decrease both in the incidence of acute appendicitis and number of appendectomies performed. This downward trend, which is progressive and continuous, may be national. A recent review of our annual surgical reports supports this fact.

During the past twelve fiscal years, 1947 through 1958, 1,823 appendectomies were performed at our hospital in Des Moines. Of this number, 1,600 were for acute appendicitis. There were four postoperative deaths, a mortality rate of 0.2 per cent. There have been no deaths since 1953, in 439 appendectomies. (Table I.)

Even though the workload has remained fairly stable during the last seven years of this survey, the incidence of appendicitis and the number of appendectomies performed has shown a steady decline from a peak of 252 appendectomies in 1949 to 72 in 1958. (Table I.) The emergency appendectomies performed likewise showed a similar decrease.

The incidence of appendicitis and appendectomies performed, calculated on a percentage basis, against the total number of surgical patients treated and the number of surgical operations performed are shown in Table II. The incidence in all three categories studied, namely total patients, appendectomies, and emergency appendectomies revealed a continuous decrease during the twelve years of this survey. Appendectomies represented 15.4 per cent of all surgical procedures performed in 1947 whereas in 1958 they were only 6.4 per cent.

Figures 1 and 2 depict these relationships. In Figure 1, the solid portions represent the

TABLE I

INCIDENCE OF APPENDECTOMY—A TWELVE-YEAR SURVEY

Year	No. of Patients	No. of Major Operations	Total No. of Appendectomies	No. of Emergency Appendectomies	No. of Deaths
1947	3,000	1,262	194	135	0
1948	3,677	1,665	252	176	1
1949	4,226	1,613	245	152	0
1950	3,880	1,723	228	146	1
1951	3,570	1,420	166	117	1
1952	3,689	1,362	169	113	0
1953	3,181	1,259	130	78	1
1954	2,965	1,126	119	76	0
1955	3,110	1,324	95	63	0
1956	3,361	1,320	95	62	0
1957	3,047	1,150	58	31	0
1958	3,134	1,132	72	45	0
Totals....	40,840	16,356	1,823	1,194	4

TABLE II

APPENDICITIS—PERCENTAGE INCIDENCE BASED ON WORKLOAD IN TABLE I

Year	Incidence of Patients (%)	Incidence of Appendectomies (%)	Incidence of Emergency Appendectomies (%)
1947	6.5	15.4	10.7
1948	6.9	15.1	10.6
1949	5.8	15.2	9.4
1950	5.9	13.2	8.6
1951	4.6	11.7	8.2
1952	4.6	12.4	8.3
1953	4.1	10.3	6.2
1954	4.0	10.6	6.7
1955	3.0	7.2	4.8
1956	2.8	7.2	4.7
1957	1.9	5.0	2.7
1958	2.3	6.4	4.0

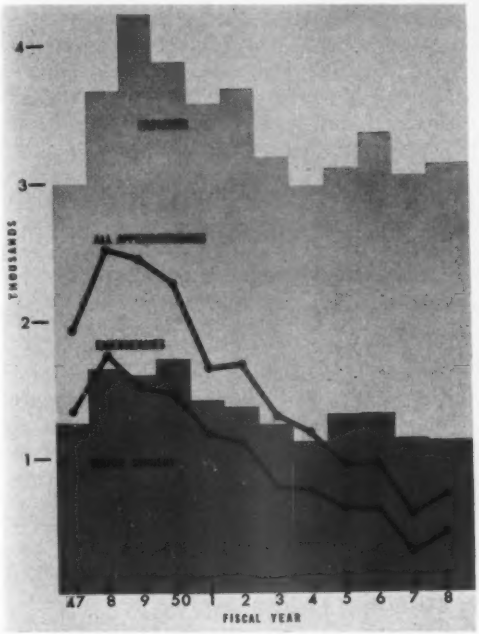

FIG. 1. Patient and major surgical workloads for a twelve-year period. In spite of a constant workload for the last six years the number of appendectomies performed shows a continuous downward trend.

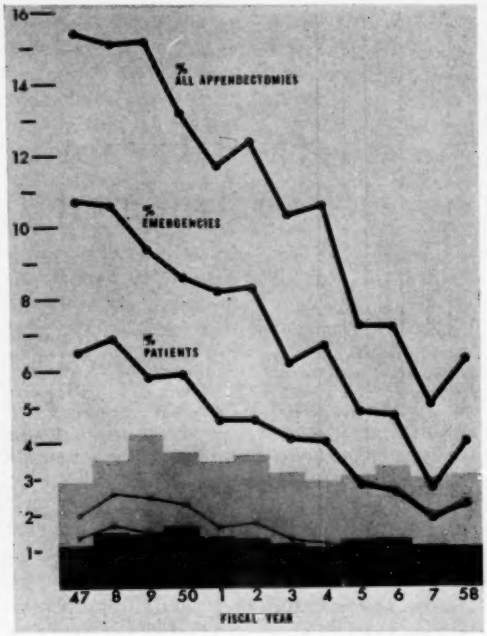

FIG. 2. The incidence of appendicitis and appendectomies performed, calculated by a percentage basis against the total workload, is shown. A progressive downward trend in all categories is noted in the twelve-year period.

total in-patient load and total major surgical procedures performed for each of the twelve years. The two lines represent the downward trend noted in both the total appendectomies and the emergency appendectomies performed. Both these lines follow the same downward trend.

Even though there has been a fairly stable workload during the last six years of this study, it is interesting to note that the rate of appendectomies performed continues in a downward direction. This trend is more effectively shown in Figure 2. The basic total patient load and operations performed, as shown at the bottom of the graph, remain fairly constant throughout these years. However, the incidence of appendicitis, the number of appendectomies, and the number of emergency appendectomies performed are definitely and progressively less frequent now than they were in 1947.

It is difficult to account for this significant reduction in the incidence of appendicitis among our adult population with no change in the type of patients admitted to our Center. It is difficult to assume that there has been a diffusion of these acute cases to other hospitals either locally or in smaller communities. The significant and progressive decline is apparently due to other causes which are not readily apparent. This downward trend of the disease in the adult population may in some way be connected with the many favorable features of life which accompany a better national economy.

SUMMARY

The incidence of acute appendicitis and the total number of appendectomies performed in the adult population admitted to our Medical Center are decreasing. A twelve-year survey, 1947 through 1958, of our surgical records revealed a progressive downward trend in both instances.

The incidence of this disease and the operation for it decreased from 15.4 to 6.4 per cent in the twelve-year period. This significant and progressive downward trend in the adult population may be in some way connected with the many favorable aspects of a better national economy. The medical reasons for this favorable change are not presently known.

Effect of Hypothermia on Mortality in Experimental Injury to the Brain

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HUBERT L. ROSOMOFF, M.D., *Pittsburgh, Pennsylvania*

From the Neurological Institute and the Presbyterian Hospital in the City of New York, New York. This investigation was supported by research grant B-1372 and special traineeship BT-348 (Dr. Rosomoff) from the National Institute of Neurological Diseases and Blindness, Public Health Service.

IN a previous communication [1], experiments were reported on in which standardized injuries to the brain were produced in dogs maintained at normothermic and hypothermic temperatures. Acute injuries to the brain at normal body temperature resulted in wedge-shaped, hemorrhagic lesions with edema of the effected hemisphere, shift of the internal structures across the midline, and trans-tentorial and brain stem herniation. Post-traumatic inflammatory reaction in the form of cerebral edema and leukocytic response was marked and progressive. By contrast, when injuries to the brain of the same magnitude were produced with the body temperature 25°C. or less, the lesions were partially hemorrhagic and the post-traumatic inflammatory reaction was markedly reduced. Cerebral edema developed to a mild degree immediately following injury and, thereafter, progression was small. The leukocytic response was absent or minimal, even thirty-six hours after injury.

The present study is concerned with the effect of hypothermia upon mortality in cases of acute injuries to the brain. The animals were observed for seven days following injury, if death did not occur previous to the end of this period. Sixty-four mongrel dogs, weighing between 10 and 15 kg. and unselected as to age and sex, were used in this investigation. Injuries to the brain were produced by the application of liquid nitrogen in a brass cylinder to the surgically exposed dura mater and subjacent part of the brain. Details of this method have been described elsewhere [1].

Lesions were produced first in forty-nine dogs at normothermic temperatures. The time of contact between the liquid nitrogen and the dura and subjacent brain was varied in order to create injuries of different magnitudes. The contact time ranged between zero and ten minutes; the size of the lesions ranged between 0.1 and 9.0 ml. The results were arrayed in nine groups, and the mortality rates of the groups were calculated as their probits. The number of animals killed, expressed in probits, was plotted against the size of the lesion in milliliters. (Fig. 1.) Analysis of the probit regression line yielded a median lethal injury (LD_{50}) of 5.42 ml. This size lesion was found to correspond to contact time of three and a half minutes.

SIZE LESION ml	No. Subj.	Deaths	Calc. Probit
0-1	4	0	3.28
1-2	5	1	3.63
2-3	3	0	3.98
3-4	4	0	4.33
4-5	3	3	4.68
5-6	10	5	5.03
6-7	8	3	5.38
7-8	4	3	5.72
8-9	8	8	6.08
TOTAL 49		LD_{50} 5.42ml	

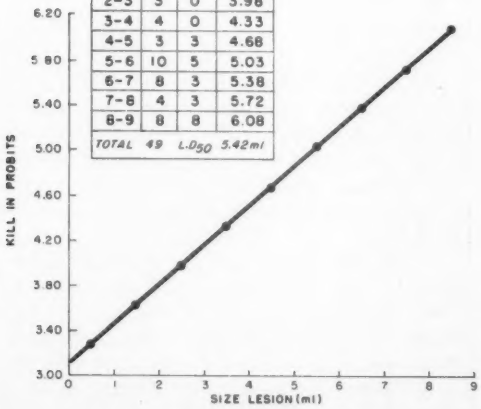


FIG. 1. The probit regression line.

Having established that a 5.42 ml. lesion could be expected to kill 50 per cent of the dogs at normothermic temperatures, this size injury, plus or minus two standard errors, was created in a group of animals at hypothermic temperatures. The lesions were produced when the body temperature was 25°C. or less, and the dogs were maintained at this temperature for one hour. They were then rewarmed and observed for seven days. Under these conditions, fourteen of fifteen "hypothermic dogs" survived. This is a mortality rate of one in fifteen and is significantly different from that of the "normothermic dogs" ("p" < 0.01).

The brain of each animal in this series was cut in order to determine the size of the lesion. Sections were taken at random for histologic examination. In brain sections from dogs whose lesions were comparable both in size and time following injury, it was seen that the inflammatory reaction in the dogs maintained at hypothermic temperatures was more advanced. That is, the animals at normal body temperature showed a temporal sequence of initial polymorphonuclear leukocytic influx into and about the lesion, followed by the first appearance of lymphocytes in forty-eight to seventy-two hours, with slight macrophagic and fibroblastic-vascular activity evident at the end of seven days. By contrast, at seventy-two hours the animals maintained at hypothermic temperatures show marked lymphocytic infiltration, and at the end of seven days there was well advanced macrophagic and fibroblastic-vascular activity.

These observations are preliminary in nature. However, the data indicate that hypothermia protects against the lethal effect of a standardized experimental injury to the brain. It is believed that the mechanism by which this is accomplished is the modification of the response to injury, as indicated by an earlier appearance of the round cell and fibroblastic phases of the inflammatory reaction. This suggests that hypothermia induces a more rapid transition from the exudative to the reparative stage of the reaction to injury.

It is concluded that hypothermia protects against the lethal effects of acute injury to the brain by modifying the post-traumatic inflammatory response.

REFERENCE

1. Rosomoff, H. L. Experimental brain injury during hypothermia. *J. Neurosurg.*, 16: 177, 1959.

Doctor Barney Brooks, 1884–1952

BYRON EDISON GREEN, JR., M.D., *Jackson, Mississippi*

Presented to the Vanderbilt Society of Historical Medicine, Vanderbilt University School of Medicine, Nashville, Tennessee, on March 18, 1954.

DR. BARNEY BROOKS was born on December 17, 1884, the first of three children and the only son of James Standifer and Emma Jane (Holmes) Brooks. Originally from Arkansas, his parents had moved to a cattle ranch in Texas, and it was here that Barney Brooks was born in a two room "shack" on the cattle plains of Jack County (seven miles from Jacksboro), Texas.

From the very beginning, the Brooks set forth principles and moral standards of life which became indelible in the character of their son. Although their surroundings were humble, Mr. and Mrs. Brooks were a gallant couple. She was a proud, loving, self-sacrificing mother with a rare sense of humor. He was a keen, spirited man—meticulous in thought and endeavor. Those who remember Dr. Brooks will agree that he inherited some of the characteristics of both his parents.

Life was simple on the plains and, at times, quite lonely. Initiative and ingenuity were required of everyone. His father believed in work, and everyone learned to do his share, including his young son. Thus, a sense of values was established early in young Barney Brooks, and he developed rapidly in mind and body.

As a youth Barney Brooks led the life of a real cowboy. He helped tend his father's cattle, and his type of dress was fitted for the type of work he had to do. He rode a horse everywhere he went, and he went wherever the work of a cowhand led him, frequently being away from home for days out on the range.

As a youngster of twelve, Barney was fully capable of thinking and acting on his own. One sweltering day, while at work out on the prairie, his father had a sunstroke. There were no roads, signs or landmarks to town which was some 20 miles away—just plains. Yet the boy of twelve summoned the courage to meet the situation, and drove the lonely 20 miles in a wagon to carry his unconscious father to the doctor.

EARLY EDUCATION AND COLLEGE

Even as he grew up in these remote surroundings, living the life of a cowhand, Barney Brooks always wanted to become a doctor. This desire never waned, and at the age of sixteen he decided to go to the University of Texas in Austin for premedical training. There was one big drawback to admission to the University, for the entrance requirement was a high school diploma and he did not have one. Due to frequent interruptions in his schooling and to the fact that he was needed to help with the cattle, there had been little opportunity for him to get an extended formal education, and thus, his early education was largely the fruit of his parent's and his own endeavors.

Consequently, with little schooling and without a high school diploma, his chances of attending the University seemed dim. His desire and determination were strong, however, and through his determined spirit he found another way of entering the University—by means of a teacher's certificate. He therefore studied with a county school teacher, gained the certificate and entered pre-medical school in 1901 at the age of sixteen.

He was graduated from the University of Texas with a Bachelor of Science degree in 1905. The four years in college had depleted nearly all the money he and his father had been able to muster, and as a result he was not able to go directly to medical school.

During the next two years he taught high school science, first in San Marcos, Texas and then in El Paso and earned enough money to continue his education. In these two years the medical world unknowingly acquired an out-

standing educator, for Barney Brooks had come to love the role of a teacher.

MEDICAL SCHOOL AND INTERNSHIP JOHNS HOPKINS UNIVERSITY

In 1907 Barney Brooks again assumed the role of a student when he entered the Medical School of Johns Hopkins University in Baltimore; he received the Doctor of Medicine degree four years later, ranking fifth in his class.

Of the top five in the class, the first four chose medical internships at Johns Hopkins; Dr. Brooks, the fifth, chose surgery. From 1911 to 1912 he interned under Dr. William S. Halsted who is represented as one of the "big four" of American medicine in Sargent's famous painting.

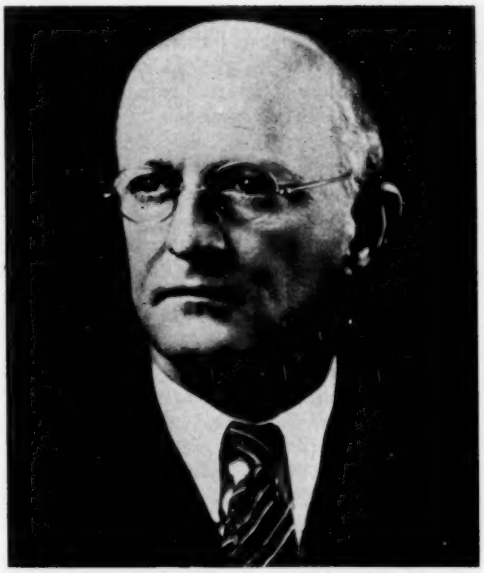
As Dr. Halsted did not offer him a position on the staff at Johns Hopkins for the year following his internship, Dr. Brooks joined the staff at Barnes Hospital and the newly reorganized Washington University Medical School in St. Louis (1912). Dr. Halsted was to regret this a few years later.

RESIDENCY AND RESEARCH—BARNES HOSPITAL

Dr. Brooks spent the first two years at Barnes Hospital in the field of investigative surgery and published his first works in the surgical literature. Through his original investigative work, he contributed much of fundamental scientific value to surgery, and to medicine as a whole. Perhaps the most outstanding research he undertook while in St. Louis was that concerned with regeneration of bone, intestinal obstruction, Volkmann's contracture and arteriography.

His studies in growth, regeneration and repair of bone established beyond question the fate of transplanted bone, and from his work the value of the use of bone grafts in surgery was more fully realized.

Until 1915 there was much confusion and disagreement concerning the symptomatology and pathology of intestinal obstruction. At that time, Dr. Brooks organized and performed a complete series of experiments on this problem and published a paper which brought order out of chaos. He showed that in intestinal obstruction, a toxin of bacterial origin is formed and that normal intestinal mucosa will not absorb this toxin. In addition, he pointed out that the presence or absence of strangulation and the portion and length of intestine involved



Dr. Barney Brooks.

influence the rate and degree of mucosal damage, which in turn limits the rapidity and amount of absorption of toxin. These principles seem beyond refutation and stand today as unchallenged truths.

In 1882, two years before Dr. Brooks was born, Volkmann had described a paralysis and contracture in muscles which followed the application of a constricting bandage to an extremity, and had expressed the opinion that the cause of this condition was obstruction of the arteries. Through the years many had agreed with him; still others had attributed the phenomenon to damage to nerves, inflammatory reaction and the formation of toxic products. It remained for Dr. Brooks, in 1922, to establish the true cause of Volkmann's contracture through the concept of occlusion of venous return. He concluded from his experimental investigation that the initial stimulus of the whole process had a mechanical basis due to increasing pressure resulting from an open artery and an occluded vein. In this process, there followed degeneration of muscle fibers and complete fibrosis which converted the muscle and surrounding tissues into a fibrous mass with the characteristic contracted deformity described by Volkmann.

In 1924, while still at Washington University, Dr. Brooks was the first person to perform

arteriography on patients by the injection of sodium iodide into the femoral artery. Until that time, there had been no accurate means of determining the location and extent of arterial occlusion in the extremities of a living patient. Thus the development and performance of this technic added a great impetus to diagnosis in vascular disorders.

Dr. Brooks planned his experimental work on a simple, logical basis and was meticulous in carrying it out—seeking perfection in his technic and adhering closely to the scientific method of investigation. In reporting his findings, he was fiercely jealous of truth and his writing reflected the clarity of his mind. He displayed the ability to grasp the basic facts in any problem, and his conclusions reflected a mind which was both disciplined and profound.

The story is told that about two years after Dr. Brooks left Johns Hopkins, Dr. Halsted approached Dr. Bloodgood with considerable excitement one day. Excitement to any degree was rare with Dr. Halsted, but he wanted to call Dr. Bloodgood's attention to a very fine piece of work carried out by a fellow named Brooks in St. Louis. Dr. Halsted wondered if they should not try to get this Brooks to come to Johns Hopkins. At this point, he was reminded that Dr. Brooks had been a surgical intern at Johns Hopkins just two years before and that he, Dr. Halsted, had let him go.

COURTSHIP AND MARRIAGE

During his first two years in St. Louis, Dr. Brooks lived in a small "family hotel." It was here that he met Miss Edith den Bleyker, a teacher from Michigan while playing bridge at the hotel; thereafter, they occasionally found time to be together.

From 1912 to 1916 Dr. Brooks was busy in his residency at Barnes Hospital. Upon completing the residency, he was offered the opportunity of remaining as a member of the department of surgery at Washington University. He decided to accept this offer even though such a move was contrary to his father's wishes. This made matters more difficult, for Dr. Brooks also had another plan which was destined to meet with his father's disapproval—he wanted to get married.

Forthwith, he wrote his parents that he planned to marry Miss den Bleyker and stay in St. Louis. In addition, he requested a loan for wedding expenses. Although his father had expected him first to establish a practice (and become financially independent), after great deliberation Mr. Brooks finally consented to their marriage, and forwarded the money. In Tacoma, Washington, on August 9, 1916, Miss den Bleyker and Dr. Brooks were married. After their marriage, Dr. Brooks returned to the Department of Surgery at Washington University.

SURGEON AND TEACHER
WASHINGTON UNIVERSITY SCHOOL OF MEDICINE

Within the next year, the United States entered World War I. Physicians were being called into military service and Dr. Brooks and his associates naturally expected to enter. It was then that the administration of the Medical School informed Dr. Brooks that some doctors were needed as teachers and he would be among those deferred from call in order to assume this essential position. Although he realized the importance of medical education during war, it was not easy for him to accept this duty when he thought of his colleagues in service. He was not completely convinced until World War II when, as Chairman of the Department of Surgery, he had to select those who would remain as teachers on his staff in the Department of Surgery at Vanderbilt University.

Accepting the appointment as teacher in Surgery in 1917, his qualities in this realm of medicine were soon recognized. From the very beginning he showed tremendous enthusiasm, interest and ability in teaching. While at St. Louis he organized a surgical pathology laboratory and a course in surgical pathology which were unsurpassed by any. This was evidenced by the fact that they served as models for other institutions about the country.

THE FAMILY

On January 21, 1918, their first child, a boy named James Standifer II, was born to Dr. and Mrs. Brooks. On June 14, 1919, they were blessed with their second child, a girl whom they named Mary Jane, both children being of great joy to their parents.

In 1925, when Jimmy was seven, both children became ill with scarlet fever and were severely stricken for weeks. (It is of interest that these children were among the first patients for whom the newly developed Dick Test was used as a means of diagnosing scarlet fever.) Although very ill, Mary Jane began to recover,

but Jimmy was stricken with mastoiditis and meningitis, and his condition became critical. Every known treatment failed to help him and, after three months of illness, Jimmy died. Dr. Brooks never completely got over the shock of losing his son, and it is thought that much of his feeling for Jimmy was transferred to his residents in the years to follow.

SURGEON-IN-CHIEF VANDERBILT UNIVERSITY SCHOOL OF MEDICINE

From 1912 to 1925, Dr. Brooks ascended the ranks in the Department of Surgery at Washington University from assistant resident to associate professor. He became an accomplished investigator and surgeon, and a capable and effective teacher. Before his death in 1922, even Dr. Halsted recognized the many attributes of Dr. Brooks and predicted that he would continue to ascend in the ranks of surgery.

In 1925 several institutions became interested in securing the forty year old Dr. Brooks as professor of surgery and head of their departments. Among these institutions were the University of Minnesota and Vanderbilt Unisity. Dr. Brooks chose the position offered him by Vanderbilt University.

In 1925, the new Vanderbilt Hospital had just been opened, and the Medical School was in a state of reorganization. Dr. Brooks had directed the reorganization of Washington Univeristy Medical School and thus was fully experienced for the undertaking at Vanderbilt University. He devoted himself with great energy and wisdom to the building of a strong department of surgery. He modeled the surgical pathology laboratory and the course in surgical pathology after the superb organization he had established at Washington University. For twenty-seven years he maintained a conscientious attitude in all administrative and educational matters pertaining to Vanderbilt, and for twenty-seven years he pursued his duties with boundless energy.

Direct in his manner, he was the sternest teacher in the Medical School and his "no" was the starkest negative at Vanderbilt. The most uncompromising taskmaster on the hospital staff, he sought no favor and regarded a request for an advantage as a demonstration of mere ignorance. In demanding the best from himself, he expected as much from his subordinates. He was sparing in his praise both of himself and his colleagues, cared not a fig for popularity, and would put up with no interference from anyone. Not everyone loved him but no one denied him respect.

CONTRIBUTIONS TO SURGICAL PROGRESS

At Vanderbilt he maintained a wide interest in all fields of surgery. He continued his investigative work and the contribution of sound principles of surgery to the literature. Facts of various circulatory phenomena were infallibly established as a result of his efforts. He contributed much to our knowledge of the effects of pressure and variations in temperature upon living tissues, and his writings stimulated interest in the problems of surgical treatment of people of advanced age. Many of his other principles of surgery were also profound. He had strong views concerning surgery of the mammary glands, gallbladder and stomach. He was among the minority who advocated subtotal gastrectomy during a period when simple gastrojejunostomy was the widely accepted method of surgical treatment for duodenal ulcer.

Among his many honors, he was very proud of his election to the Presidency of the Southern Surgical Association in 1942. In his Presidential Address to the Association it was shown that even though he was "old guard" and rigid in his manner, he was up-to-date and progressive in medical thought. The subject of his address was "Psychosomatic Surgery." This phase of surgery, which he pioneered, has through the years aroused the interest of clinicians in all fields of medicine. The former Dean of the Yale University School of Medicine wrote Dean Leathers of Vanderbilt University of his enlightenment on the subject, saying, "I did not know that there was any surgeon in the world who knew patients had a psyche." And in a complimentary letter to Dr. Brooks, the Director of the Division of Medical Sciences of the Rockefeller Foundation wrote, "In talking about the psychosomatic aspects of surgery . . . you approach the full meaning of both psychiatry and surgery."

THE TEACHER

To say that Dr. Brooks was well known would be an understatement. His reputation crossed the oceans, spreading to every part of the world; perhaps the one thing for which he was most noted was his teaching. As a master teacher, he showed consistent interest in high

Caricature of Dr. Brooks.

ideals and proper standards of medical education, and it was probably through teaching that he made his greatest contribution to the welfare of mankind.

One has only to read the list of his resident staffs to discover innumerable outstanding surgeons who were influenced by his training and who today are passing on the sound principles of surgery which he imparted to them. He has not failed to gain the lasting affection of these men who came to know him well. They mention him frequently and readily attest to his unmatched agility as a teacher of surgery. Through them his precepts of surgery are perpetuated and his contributions multiplied with each successive generation.

There are also many who, as students, were influenced by Dr. Brooks' teaching. He had a peculiar knack for stimulating a medical student in such a way that what he taught was never forgotten.

At his clinics, many a student was called down to the floor of the amphitheater for questioning on the case being presented. Alone (and thrown to the lions), his was a condition of great inner distress. With the student suffering from rapid pulse and respiration, every moment was endowed with meaning; it was truly an unforgettable experience.

When asking a question, Dr. Brooks had a characteristic way of setting his jaw, looking directly at the student and waving his hand toward him while he waited for an answer. On one occasion, when a student's answer was obviously not just to the point, the retort came immediately. After listening to as much of the extraneous information as he could stand, he interjected, "My God, man, I ask you for the biscuits and you pass me the gravy!"

LEISURE

During his moments of leisure, Dr. Brooks found time for a change in mood. He enjoyed bridge, golf and working on his farm in Williamson County, Tennessee. At bridge, his next move was always unpredictable and he was constantly shocking his partners by bidding what they considered the impossible—and then making the bid. Many of his fellow golfers were awed at his "common sense approach"to the game and, although they played as orthodoxly as they knew how, he usually had fantastic results and matched them point for point. Like most golf enthusiasts, weather was not important and it was not uncommon for him to play in a torrent of blinding rain. Having been raised on a farm-ranch, he delighted in the growth of his crops and in riding horseback.

His rare expression of geniality was probably more readily manifest at social events than on any other occasion. At the surgical staff softball games he fully enjoyed the activities; at bat or on second base, he was with the younger surgeons all the way, enjoying every minute. His home was a place of enjoyment to everyone. As a host, his hospitality was unlimited. This was often proved as he had groups of his house staff to dinner on frequent occasions throughout the year.

Not only did he entertain, but he was, in turn, frequently entertained by his close associates. Annual birthday parties were given in his honor.

In December 1944, the Surgical House Staff at Vanderbilt gave a surprise dinner in celebration of Dr. Brooks' sixtieth birthday. Some 120 guests attended the dinner, including a number of distinguished physicians from various parts of the country. At the dinner eleven brief speeches were made; the following excerpts from three of these are of particular interest.

Dr. Evarts Graham (Professor of Surgery, Washington University School of Medicine, St. Louis): "Before I went to St. Louis, I was

acquainted with the careful and logical experimental work which Dr. Brooks had done. . . After my arirval there I was enormously pleased to find the excellent course in surgical pathology which he had organized . . . "

Dr. Alton Ochsner (Professor of Surgery, Tulane University School of Medicine, New Orleans): "In the fall of 1918 I transferred to Washington University from the University of South Dakota after having completed my first two years of medicine in that institution. There was never a more unsophisticated and greener individual than I was when I matriculated at Washington. The very first exercise that I attended was a diagnostic clinic which was conducted by Dr. Brooks. The case which was presented was one of acute hematogenous osteomyelitis, and those . . . who have heard Dr. Brooks hold a clinic can easily realize how impressed I was by that presentation. The orderly manner and the chronological development of the case made a condition about which I knew nothing appear so simple that I realized here was a teacher who had . . . few, if any, equals."

Brig. Gen. Hugh Morgan (Professor of Medicine, Vanderbilt University [In Absentia]; Chief Consultant in Medicine, Office of the Surgeon-General): "I've moved around a lot amongst our graduates during the past three years. Dr. Brooks is almost always the first faculty name brought up . . . —in North Africa in a tented hospital, in the Persian desert, in New Guinea, and God only knows in how many hospitals in this country. His students are always . . . reorienting him to their expanding professional experience . . . I think one might designate this the 'pay off' in . . . teaching."

Due to the conditions of war at the time many of Dr. Brooks' friends were unable to attend, but almost without exception they responded with messages to the guest of honor.

For the same reason many of Dr. Brooks' former students, house officers and residents were unable to celebrate their Chief's birthday with him because of the war, but they wrote glowing letters of tribute, admiration and affection from every theater of operation the world over. Parts of the following letters express the general sentiment of all of them:

Lt. Col. James A. Kirtley: "The surgical service that you are running 'by proxy' overseas would like to be among the group honoring your birthday. I feel that the service that has been rendered by the men and women of this unit whom you have taught and trained is a tribute to a great teacher . . . the close teamwork, the willingness to put in long hours to attain a better result and the 'surgical alertness' of the surgical service are due to your training at Vanderbilt."

Capt. Rudolph Light: " . . . In common with every one of his students I have forgotten little of his teaching and none of that imparted when I was up for one of his clinics or ward rounds. No one who has survived an hour of his pertinent questioning, who has gone through that soul-searing moment when the mind becomes blank and the body aches to fade through the floor out of his sight can fear anything . . . the ultimate in emotion has already been reached, and you never forget!"

After the reading of these letters, a watch and chain were then presented to Dr. Brooks. Dr. Brooks was a man of sentiment, and although he usually kept it closely guarded he realized the genuineness and sincerity of this tribute and was deeply moved by it.

Copies of the speeches, an account of the dinner, and all the letters and telegrams were later bound to form a Birthday Scrapbook and presented to Dr. Brooks. This collection was treasured by him and remained in his guarded possession the rest of his life.

THE LATTER YEARS

Until 1946, Dr. Brooks was apparently in good general health; he was vigorous in filling his heavy schedule, and when not at work in the hospital he was continuously active. Occasionally, he would suffer some minor injury while working (at manual labor), at home or on his farm. He was a heavy smoker and had frequent flare-ups of upper respiratory infection, sometimes putting him in the hospital with mild bronchopneumonia. As soon as he recovered he would work as hard as ever, smoking again and playing golf in the rain.

As early as 1932 he was found to have a blood pressure of 152/92 mm. Hg; however, he denied all symptoms of hypertension. In 1946 his blood pressure was 175/95 mm. Hg and, although an electrocardiogram indicated active myocardial disease, he had been free of symptoms and continued his daily routine. In 1947 and 1948 however, he began having mild symptoms of hypertension, which became so

noticeable that he could no longer ignore them. He was admitted to the hospital on February 12, 1949, and was found to have an early stage of congestive heart failure. Electrocardiograms were compatible with the suspicion that he had had a coronary occlusion. These findings and a blood pressure of 190/115 mm. Hg were attributed to hypertensive arteriosclerotic heart disease; a salt-free diet was prescribed and bed rest enforced. Dr. Brooks was never an ideally cooperative patient, and this schedule was almost more than he could bear. However, he improved rapidly with the administration of digitalis and was discharged after five weeks, with instructions to limit his activities.

Gradually, however, he began increasing his pace. In the next two years, he had occasional episodes of mild congestive failure and was twice readmitted to the hospital for diagnostic study regarding abdominal symptoms. Relatively active during this time, he continued to come to his office and attend to his work although his health was rapidly failing.

His pace had definitely slowed, however, and Dr. Brooks himself began to recognize this. On June 25, 1951, about one year prior to his scheduled date of retirement, Dr. Brooks presumably suffered thrombosis of the left middle cerebral artery and a right hemiplegia developed. Even then, despite the weakness of half his body, he was determined to return to the duties at his office and did so as regularly as possible. Although an acting head of the department assumed much of the burden, insofar as he was able Dr. Brooks was always at his desk; he carried on until February 12, 1952, when a sudden severe right cerbral hemorrhage left him critically ill. Yet he survived this attack and several other severe complications. He died on March 30, 1952.

CONCLUSION

Vanderbilt University, the field of surgery, and the entire medical world suffered a great loss when Dr. Brooks died. He was unique. From an obscure beginning, he was determined to become a doctor. The obstacles were not few, and at times he advanced on courage and determination alone. He did not give up easily on any matter. This was the way he lived and the way he died. Just when one thought he was beaten, he came back fighting all the harder.

I think that it can be said without reservation that Barney Brooks attained the one goal which most men seek in life—that is, the world benefited from the fact that he once lived, and because of the contributions he made during life the world continues to benefit, even after his death.

Duodenal Mobilization in Gastrectomy

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SINCE surgical treatment for duodenal ulcer is being advised more often by the medical profession and sought more frequently by patients, it is important to improve the technic so that complications due to the operation itself may be held to a minimum. Whenever possible, the removal of the ulcer is imperative if future bleeding and pain are to be eliminated [1]. Finney has stated that "it should be constantly borne in mind that upon the satisfactory mobilization of the duodenum depends the success of the operation" [2]. However, persistent efforts to remove duodenal ulcers in all patients may make the procedure difficult and dangerous because of the proximity of the pancreas and the common duct. For example, when confronted with low-lying perforating ulcers of the posterior wall with the formation of abscesses onto the pancreas, extensive dissections should not be attempted. Whenever the risks are too great, the disease may be satisfactorily inactivated by simple resection through the open ulcerated area, followed by modified closure that utilizes the pancreas to cover over the suture line [3].

The purpose of this study is to describe a planned type of operative procedure found to be valuable during the past four years in almost all operations for duodenal ulcer in which the lesion was considered resectable. Based upon the normal and pathologic anatomy of the pancreaticoduodenal region, a technic will be described whereby one may accomplish dissections of ulcers by working in relatively "safe zones," thus avoiding trauma to the pancreas and bile ducts. The dangers of immediately encircling the posterior wall of the duodenum by an incision into the pancreaticoduodenal adhesion, thus exposing the pancreas and ducts to early trauma, will be presented. On the other hand, the advantages of alternately dissecting from either extremity of this adhesion toward the middle will be described. Basically, mobilization of the proximal duodenum is accomplished by freeing it from its two attached structures, namely, the pancreas posteriorly and the hepatoduodenal ligament superiorly. The pancreas is the more difficult structure to dissect from the duodenum because it is flat, has no capsule and is firmly adherent to the posterior wall of the duodenum as well as the abdomen.

The secreting lobules are held together only by an adventitious coat of fine connective tissue that makes separation difficult. The hepatoduodenal ligament is the tough fibrous structure that forms the anterior boundary of the foramen of Winslow. (Fig. 1.) It arises from the porta hepatis above and proceeds inferiorly to divide into two layers; the first, a superficial portion, fans out to the right in a web-shaped manner and is attached to the superior (lesser curvature) surface of the first part of the duodenum [4]. The attachment to the duodenum occupies a distance of 3 to 4 cm. beyond the pylorus. To the left, the superficial layer is continuous with the lesser omentum, while to the right it fuses with the deeper layer to help form the sharp anterior edge at the entrance to the foramen of Winslow. This layer of the ligament is composed of peritoneum, fibrous tissue and numerous small blood vessels. The deeper layer of the hepatoduodenal ligament contains the bile ducts, the hepatic artery, the

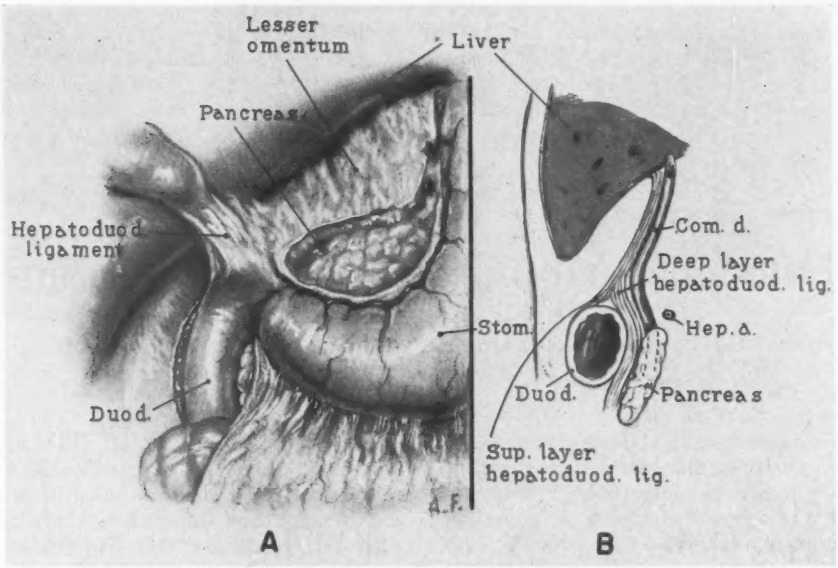

FIG. 1. A, the hepatoduodenal ligament as the right free portion of the lesser omemtum. B, a cross-section of the ligament showing the division at the duodenum into superficial and deep portions.

portal vein, nerves, lymphatics and the connective tissue enveloping all these structures. It then continues downward and disappears into the transverse mesocolon and the duodenorenal ligament.

To avoid pancreatic complications postoperatively, one must "walk a tight rope" of clean dissection of tissue planes. On one side is the posterior duodenal wall which must be cleared and freed so that it can provide sufficient healthy tissue for a leak-proof closure. On the other side is the parenchyma of the pancreas, an area not to be invaded if one is to avoid trauma to its ducts or secreting tissue.

OPERATION

The first step in the operation is the incision of the peritoneum to the right of the duodenum following the method of Kocher [5]. However, in the direction of the pylorus this Kocher mobilization maneuver is limited by the portal structures and the fusion of the two layers of the hepatoduodenal ligament. The surgeon will find it necessary to stop at this point to avoid excessive bleeding and possible trauma to the deeper structures. After severing the left gastric vessels and clearing the greater and lesser curvatures of the stomach of their omenta down to the pylorus, the proximal part of the stomach is sectioned and held to the right of the patient by an assistant so as to expose the posterior wall of the duodenum with its pancreatic adhesion. Since the real problem in most cases of gastrectomy is the presence of the ulcer on the posterior wall, some pancreatic separation is nearly always required in order to provide enough duodenum for closure. The broad, intimate attachment of pancreas to the posterior wall is similar to the large, firm inflammatory adhesions often encountered between other viscera. The same basic surgical methods of separation must be employed. For example, if the separation of a large, firm adhesion of intestine to the urinary bladder is contemplated, the safe approach is not to start with a frontal surgical attack upon the central portion of the adhesion. On the contrary, one should resort to the fundamental surgical principal of developing the separation from either end toward the middle. At the ends such an adhesion is thinner and more accessible; by manipulation one can easily visualize all the areas of attachment. In this manner, penetration into the bladder or bowel is usually avoided. Likewise, in pancreaticoduodenal separation, the pancreas is eased away from the duodenum by dissecting alternately along the superior and inferior borders of the head of the

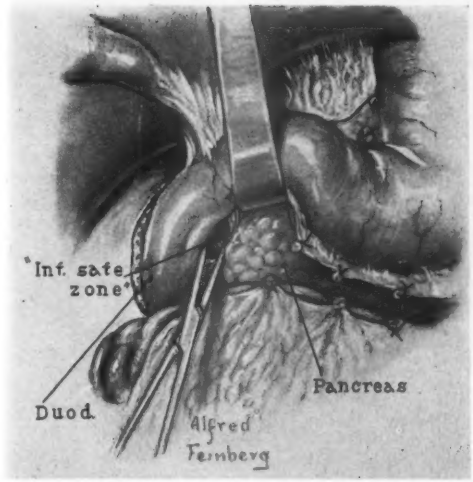

FIG. 2. Beginning the duodenal mobilization at the inferior safe zone at the lower border of the duodenum, just beyond the pylorus.

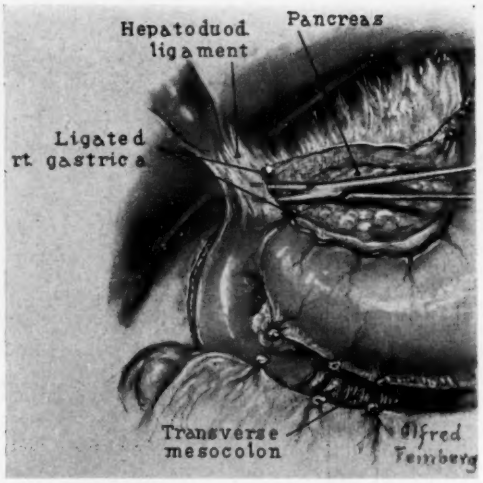

FIG. 3. Dissecting and incising the superficial portion of the hepatoduodenal ligament, thus dropping the duodenum and revealing the upper limit of the pancreaticoduodenal adhesion.

pancreas. Superiorly, the dissection at first centers about the superficial layer of the ligament in order to free the upper border of the pancreas. The inferior border can be exposed more easily by freeing the omentum and gastrocolic ligament down to the pylorus. The approach to each region is through "safe zones," avascular areas that are not too close to important structures. From experience, two such areas have been found and therefore utilized for the beginning of pancreaticoduodenal separation.

Inferior Safe-Zone Starting Point. Along the lower border of the duodenum, just beyond the pylorus, an avascular space can be developed by incising the peritoneum and prying the pancreas and other tissues away from the duodenum [6]. By inserting sharp, pointed hemostats and sectioning the tissue between them in stages, all omental attachments to the pylorus and proximal duodenum are severed. (Fig. 2.) The surgeon performing the dissection has thus far intentionally hugged the duodenal wall in an attempt to avoid the major blood vessels and to produce a clean duodenal stump. The use of mass ligatures instead of fine clamps in this area usually does not result in such a well cleared duodenum and may interfere with the major blood supply in this area, namely, the gastroduodenal vessels. Fortunately, these lie on the pancreatic side and remain untouched if the dissection is clean. The result is a clearly separated duodenum on its inferior border and a good view of the smooth attachment of pancreas to the posterior duodenal wall. The release of the pylorus and proximal duodenum from their omental attachments permits a slight spreading apart of the duodenum from the pancreas so that the line for dissection can now be clearly seen. As previously stated, the only attachment of pancreas to duodenum in this area is by means of fine strands of connective tissue and minute blood vessels. By continuing this dissection from the inferior pancreatic border upward between fine clamps around the duodenal wall it is possible to separate the pancreas from the intestine intact and without bleeding. At this stage only about one-third of the fixed inferior pancreaticoduodenal junction can be freed with ease and safety. The connection between the two viscera is too smooth and too close at this deep level to avoid unnecessary trauma if one persists in dissecting further. The operation must now be shifted to the superior extremity of the adhesion, a safer area in which to continue the separation of the structures, by incising the superficial layer of the hepatoduodenal ligament. In this manner the upper border of the pancreas can be released from its fixed position to the posterior abdominal wall and made more available for later dissection from the duodenum from below.

Superior Safe Zone. (Fig. 3.) The pyloric

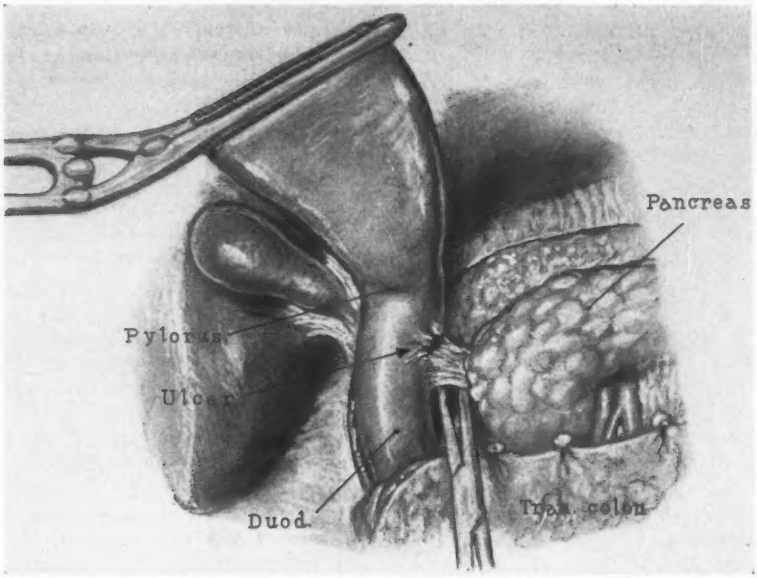

FIG. 4. After dissecting the pancreaticoduodenal adhesion at either extremity, a pedicle of pancreatic tissue results. This can now be released without trauma to the pancreas or duodenal wall.

vessels with the balance of the attached lesser omentum are now sectioned between clamps from the patient's left to right revealing the right lateral limit of the omental bursa. This maneuver frees the stomach to a point just beyond the pylorus. The operator will do well to bear in mind that the superior and lateral surfaces of the duodenal loop are relatively safe zones for dissection, and that the superficial layer of the hepatoduodenal ligament is the direct continuation of the lesser omentum onto the duodenum. However, he must also remember that at a deeper level lies the main portion of the ligament, which, together with bile ducts and vessels, forms the anterior boundary of the foramen of Winslow, all in the same posterior plane as the pancreas.

The next step is to incise the superficial layer of the ligament, thus dropping the duodenum and loosening the superior margin of the pancreaticoduodenal attachment. In non-obese patients, the superficial layer of the hepatoduodenal ligament is thin, relatively avascular and easily separated from the deeper part when approached from the patient's left. This can be safely sectioned in stages all around the bend of the duodenum onto the beginning of the second part. If the two layers of the ligament are not already separate, a space may be developed between them by careful dissection. This is made possible because the omental bursa is continuous on the right side with this interligamentous area and may be utilized as a guide to separate the two parts of the ligament. At this stage no attempt is made to section the entire superficial portion of the ligament; only about 2 cm. is freed from the duodenum. With each successive step the duodenum will be observed to roll further downward off the pancreas, thus exposing the smooth, flat surface of that gland as it lies deeply against the posterior wall. At the same time the upper extremity of the pancreaticoduodenal adhesion becomes better delineated.

The surgeon should then temporarily discontinue the operation from above to view the results of the duodenal mobilization thus far. He will observe that the superior and inferior surfaces of the first part of the duodenum have been partially freed. Also, because of the sectioning of the ligament superiorly and the partial separation of the pancreaticoduodenal attachment inferiorly, a portion of pancreatic tissue appears to be hanging from the duodenal wall by a narrow pedicle. (Fig. 4.) Closer inspection discloses this pedicle of pancreatic

parenchyma to be attached to the duodenum only by means of fine blood vessels and delicate strands of fibrous tissue. The dissection should then be continued upward at the inferior margin of the pancreas, where successive double clamping and incising of the apex of the pancreatic adhesion causes it to fall away gradually from the duodenal wall. A condition is now reached in which the pancreas ceases to hang from the duodenal wall pedicle fashion and again presents a smooth, flat attachment with no evident plane of cleavage. If one persists in the dissection of the pancreas from below and an attempt is made to separate the two organs at a deeper level in the wound, the accessory duct of Santorini will eventually be encountered, then the common bile duct and the main pancreatic duct of Wirsung. The ducts may be distinguished by the whiteness of their walls, whereas pancreatic tissue presents a darker color. Most important is the accessory duct of Santorini which crosses the bile duct before that structure is joined by the pancreatic channel and lies more superficial to the duct of Wirsung. It usually empties separately into the duodenum at a point 1 to 2 cm. above and more anterior to the main duct and therefore nearer the pylorus [7]. However, one must remember that there are many variations in the anatomy of the pancreatic ducts [8,9].

Therefore, to secure a safe area in which to continue the duodenal mobilization, the operation is again shifted to the superior surface of the duodenum where further dissection of the ligamentous tissue results in an additional mobilization of the duodenum from the pancreas. This maneuver from above for a second time, undermines the pancreaticoduodenal junction superiorly so that the pancreas once again takes the shape of a pedicle as it hangs from the duodenum.

This scheme of dissecting alternately, at each extremity of the adhesion, will eventually carry the mobilization by successive stages to a depth beyond most duodenal ulcers and thus provide enough good duodenal wall for closure. The last remnant of the superficial layer of the hepatoduodenal ligament to be sectioned is usually thicker than the rest and lies farthest from the pylorus. Here the Kocher maneuver is terminated. Incising this remnant of tissue immediately releases a large area of the superior surface of the duodenum for closure. The deeper portion of the duodenum then emerges from the depth of the wound to a superficial plane in the operative field where the duodenal inversion suturing can be accomplished with ease.

Since most ulcers requiring surgery are located posteriorly and superiorly, more scar tissue will be found in these areas, and an otherwise thin superficial ligament may be transformed by fibrous tissue into a thickened structure. In advanced cases, such scar tissue may have the consistency of cartilage, wherefore one is compelled to use the sharp blade of a scalpel to start the procedure of developing an interligamentous space for freeing the duodenum. However, the surgeon may proceed with confidence if he follows the principle of freeing only ligamentous tissue close to the superior border of the duodenal loop. The area to avoid is the deep plane of the pancreas where the ducts lie closely in relationship to the second part of the duodenum. If the dissection is accomplished in a clean manner and in a field made relatively bloodless by meticulous clamping and ligation of even small vessels, one can be relatively certain at all times of the extent of the dissection and the proximity of important structures.

Closure of the duodenal stump over a small intestinal crushing clamp is preferred whereby the suture line is made retroperitoneal by burying it under the head of the pancreas by means of several pancreaticoduodenal sutures.

When the posterior duodenal wall is inadequate for closure and inversion, the Nissen modification is resorted to. Briefly, this technic consists of a series of inversion sutures that roll the intact right lateral wall under the head of the pancreas, thus plugging and covering the duodenal stump. Regardless of the method of closure used, only non-absorbable sutures have a place in duodenal surgery. A split rubber tube drain is used in all operations.

COMPLICATIONS IN MOBILIZATION

Lahey spoke prophetic words when he stated that "the mortality of duodenal ulcers is largely related to whether or not the duodenal ulcer is successfully removed without damage to the pancreas, one of the pancreatic ducts, or without injury to the common bile duct" [10]. In reviewing the surgical literature on complications in gastrectomy, one is impressed with the important role of surgical trauma. All authors stress the gentle handling of tissues and avoiding interference with the major vascular supply.

One should decide at an early stage in the operation if it will be safe to remove the duodenum with its ulcer; one should not, as a second choice, resort to a more conservative procedure after having failed to accomplish the maximum. Usually such a failure in complete mobilization is attendant with much trauma and serious damage to tissue. The special complications of duodenal separation may be listed as pancreatitis, trauma to bile and pancreatic ducts, and duodenal fistula.

Pancreatitis. Even though the pancreas may manifest an acute pathologic condition from remote areas and conditions unrelated to its immediate surroundings, it still remains the most vulnerable important structure in duodenal mobilization. Perryman and Hoerr and Mahaffy and Howard [*11,12*] found that the serum amylase is elevated immediately following partial gastrectomy operations. In serial studies over a three-day period, the serum amylase was elevated in 30 per cent of the patients, thus indicating trauma to the pancreas. Clairmont [*14*] collected a series of 145 cases of pancreatitis occurring postoperatively and found that ninety-one had followed gastric operations. Numerous other workers confirm these findings since the pancreas is subject to trauma because of its intimate relationship with the duodenum. The direct causes of pancreatitis also include: (1) deprivation of the blood supply, especially injury to the gastroduodenal and superior pancreaticoduodenal vessels [*15*], and (2) sludging and concentration of the secretions because of dehydration, atropine and anesthesia. We cannot share the belief of Ogilvie [*16*] that sutures taken in the pancreas to reinforce the duodenal suture line can cause serious trauma. Such sutures are usually superficial, of very fine silk and located at a distance from the large ducts. The pathologic condition in pancreatitis may vary from a simple pancreatic edema, to fat necrosis, hemorrhagic necrosis and suppuration.

The onset of the disease usually occurs on the first day following surgery, with pain in the epigastrium and back, fever, leukocytosis and abdominal distention. The level of serum amylase is elevated early. Acute pancreatitis must be diagnosed from coronary occlusion, obstruction of the small bowel or a suddenly opened stump, yet many cases are missed or wrongly diagnosed. The treatment consists of correction of electrolyte balance and replacement blood transfusions, gastrointestinal suction to avoid duodenal stasis, and the administration of antibiotics and vagal blocking agents. These patients are critically ill and few recover. In our series of 170 patients, the only fatality was due to acute pancreatitis.

Injuries to the Bile Duct. Since the common bile duct lies deeply in the wound, there should be little occasion to be near enough to this structure to consider it an operative hazard. In the surgery of ulcers, as distinct from cancer, it would be safer to forego dissection of such a deep lesion and resort to some other type of closure technic. However, the surgical literature still contains references to injury and obstruction of the common bile duct [*17*]. Early jaundice may indicate angulation or torsion of the common bile duct due to turning in too much of the duodenal stump or stricture of the duct. Late jaundice may denote obstruction from inflammatory scarring. However, jaundice may also result from reactions to blood transfusions and have nothing to do with trauma to the bile duct. Should a lacerated or obstructed bile duct occur, cholecystojejunostomy should be performed. All the other measures for draining fistulas should also be instituted, such as replacement of fluids and electrolytes and suction drainage.

Injuries to the Pancreatic Duct. The accessory duct of Santorini is the duct more likely to be injured since it is located more anteriorly and superficially than the other structures. By injecting 200 specimens with radiopaque material, Millbourne concluded that in 50 per cent of operations for duodenal ulcer, the duct of Santorini was exposed to danger [*18*]. The duct of Wirsung is liable to injury only at the neck of the pancreas where it turns down deeply into the head. Only in 10 per cent of the patients is the duct of Santorini the main channel. In other words, in most patients it does not matter if this duct is ligated, but in the 10 per cent in whom it is the main duct, a fistula or even pancreatitis may follow. Whenever the duct of Santorini is exposed during the operation, it should be carefully ligated with silk or cotton.

Pancreatic fistulas result in the loss of 500 to 2,400 cc. of total secretion; the loss of electrolytes, especially sodium, potassium and calcium; impaired digestion with weight loss; and autodigestion of the skin by trypsin [*19,20*]. Conservative therapy succeeds in 80 per cent

of the cases with sump drainage, diet and replacement therapy with water, sodium and bicarbonates [21]. Locally, the skin must be protected from digestion by the use of vaseline, aluminum and tannic acid preparations. Surgical correction requires the implantation of the pancreatic fistulous tract into a portion of the intestine, a difficult procedure and one to be used only as a last resort.

Duodenal Fistula. Such fistulas combine the problems peculiar to high level intestinal fistulas with certain additional features related to their specific duodenal region. Normally, the gastrointestinal tract accepts proximally huge quantities of fluid and electrolytes, a large proportion of which are reabsorbed further along the tract. Duodenal fistula, being a high level gastrointestinal outlet, rapidly depletes the organism with far-reaching effects. Massive loss of fluid and electrolytes, deranged gastrointestinal motility and certain profound chemical changes in the blood are seen. Up to 7 L. a day, containing as much as 2.5 gm. of sodium chloride, may be lost through the fistula even though nothing be taken by mouth. The chief fluid losses through a fistula of the duodenum are swallowed saliva and gastric, duodenal, pancreatic and biliary secretions. Chemical changes in the blood are characteristic, with depressed chloride, elevated carbon dioxide combining power and non-protein nitrogen levels. Thus, as in high intestinal obstruction, the untreated patient with a duodenal fistula is confronted with starvation, alkalosis, dehydration and uremia [22].

Sufficient duodenal mobilization, a viable duodenal wall, interrupted non-absorbable sutures and the protective covering of the pancreas over the suture line are good insurance for a non-leaking duodenal stump. Excessive stripping of blood vessels, especially the gastroduodenal and pancreaticoduodenal vessels, strangulating and cutting sutures, poor hemostasis with uncontrolled or delayed hemorrhage may all lead to formation of a fistula. The blow-out of a duodenal stump following gastrectomy is called the "end type" duodenal fistula since there is an absence of intestinal continuity. According to Bartlett, it carries a 14 per cent mortality rate [23].

The patient should be followed-up with a strictly tabulated intake-output chart, in order to match one for the other in daily balancing of fluid, with a positive balance of 1,500 to 2,000 cc. to provide the kidneys with sufficient fluid for adequate clearance of nitrogenous waste. Rowntree [24] has estimated the total fluid poured into the average human duodenum in twenty-four hours to be 6 to 7 L., or two to three times the total volume of plasma. The administration of 6 to 7 L. of fluid daily may be necessary while the fistula is draining copiously. Such drainage is accomplished by constant suction through a negative pressure pump. Meanwhile, it must be replaced by like amounts of normal saline or its equivalent, blood transfusions daily, and parenterally administered protein hydrolysates and plasma. Calories are supplied by carbohydrates in the form of glucose administered intravenously to spare the protein. The vitamins given are ascorbic acid, thiamine, riboflavin, nicotinic acid, B_{12} and 2 cc. of liver extract daily. Abbott and Holden have emphasized the occurrence of hypoprothrombinemia with intestinal fistulas and the importance of therapy with vitamin K in its correction [25]. For prevention of digestion of the badominal wall, many ingenious methods have been used but the surest are constant suction, positioning the patient upside down on a Bradford frame and any of the local applications previously mentioned such as aluminum powder and vaseline.

Surgical treatment is limited and used only when conservative measures have been given an extended trial. Available surgical measures include distal feeding, jejunostomy, simple excision and closure, and duodenojejunostomy. In the last patient we operated upon for duodenal fistula, prior to the series presented herein the omentum and gallbladder were used for plugging and covering the draining tract. The gallbladder made a substantial supporting structure and the good result was attributed to this.

EXPERIENCE

A study of Table 1 will disclose that during the past four years a total of 170 gastrectomies have been performed for patients with duodenal ulcer according to the previously described technic. All patients recovered from the surgery and left the hospital with healed wounds, except one fatal case of a patient with acute pancreatitis and one patient with a non-fatal duodenal fistula. Patients with ulcers of the anterior wall numbered forty (23.5 per cent of the total). Many had acute ulcers with impending perfora-

TABLE I
ANALYSIS OF 170 POSTGASTRECTOMY CASES FOR DUODENAL ULCER—A FOUR-YEAR STUDY

Data	No. of Cases	Per cent
Location of ulcers (170 cases):		
Anterior wall	40	23.5
Posterior wall	95	55.9
Combined anterior and posterior walls	35	20.6
Method of duodenal closure (170 cases):		
Closed method (over crushing clamp)	137	80.6
Open method (Connell suture)	24	14.1
Nissen closure	9	5.3
Postoperative complications:		
Leakage of duodenal stump	1	....
Acute pancreatitis	1*	....

* Patient died.

tion and adherence to omentum, liver or gallbladder. Others were patients who had previously had perforated ulcers and had returned for subtotal gastrectomy after a two or three month interval of convalescence. Ninety-five or 55.9 per cent had ulcers of the posterior wall that caused them to seek operation because of hemorrhage, intractable pain or obstruction. Many ulcers were perforated posteriorly and had large pancreatic abscesses. There were thirty-five (20.6 per cent) cases of combined ulcers, that is, a separate anterior and posterior ulcer in the same patient. In this combined group were included single large ulcers that involved both anterior and posterior walls since they resembled separate ulcers of the anterior and posterior walls because of their pathology, symptoms and treatment.

Never have we had occasion to resort to the precautionary measures of inserting a tube in the common duct in order to identify that structure and its point of entrance into the duodenum [*26*]. Nor have we ever seen the necessity for attempts to introduce the finger into the duodenum to identify the papilla of Vater or the lesser papilla. Any ulcer that lies in such a vulnerable part of the duodenum should not be excised, but instead treated surgically in a much safer manner.

Several interesting conclusions were drawn from a study of the methods used to close the duodenum. If the area of ulceration was not too extensive and not too deep, the mobilization was readily accomplished. The duodenum was easily closed over an intestinal crushing clamp according to the closed method. One hundred thirty-seven patients (80.6 per cent) were treated by this closed technic. When the pathologic condition was more extensive and the mobilization accomplished with difficulty and less completely, the open method with a Connell suture was used. This occurred in twenty-four (14.1 per cent) of the patients. In nine patients (5.3 per cent) no attempt was made at duodenal mobilization and Nissen's procedure was used at the outset.

SUMMARY AND CONCLUSIONS

1. The most difficult part of gastrectomy for duodenal ulcer is the mobilization of the duodenum. To avoid future pain or hemorrhage, the resection should include the ulcer-bearing portion whenever possible.

2. A planned type of duodenal mobilization has been described whereby the operation proceeds along planes of normal tissue, thus avoiding trauma to the surrounding important structures.

3. At the beginning of the operation the intimate adhesion between pancreas and duodenum should be separated at either extremity toward the middle and not at the central portion.

4. The dissection for mobilization begins at the inferior safe zone to the right of the inferior border of the duodenum, just beyond the pylorus.

5. The upper extremity of the pancreaticoduodenal adhesion is approached through the superior safe zone by sectioning the superficial layer of the hepatoduodenal ligament.

6. The special complications of duodenal separation are pancreatitis, trauma to bile and pancreatic ducts, and duodenal fistula.

7. Over a period of approximately four years, 170 gastrectomies have been performed for duodenal ulcer according to the foregoing technic, with only one fatality. Nine patients were treated by Nissen's method and in one of these a duodenal fistula developed.

8. With the previously described technic, it has been possible in four-fifths of the patients to secure sufficient mobilization of the duodenum to perform the closed type of inversion over a crushing clamp.

9. The best insurance for a leak-proof duo-

denal stump is a clean duodenal mobilization, a viable duodenal wall, interrupted non-absorbable sutures and the protective covering of the pancreas over the suture line.

10. When striving for a good result in the surgery of duodenal ulcer, one may apply some of the wisdom of the English essayist, Joseph Addison: "If you wish success . . . make perseverance your bosom friend, experience your wise counsellor, and caution your elder brother. . . ."

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Vertebral Body Fusion for Ruptured Cervical Discs

DESCRIPTION OF INSTRUMENTS AND OPERATIVE TECHNIC

RALPH B. CLOWARD, M.D., *Honolulu, Hawaii*

A NEW operation [1] for removal of a ruptured intervertebral disc through an opening in the vertebral bodies by an anterior approach has been designed to relieve pain in the cervical nerve roots. Pain in the neck, shoulder and arm due to cervical spondylosis (the degenerated disc) is also cured by fusion of the vertebral bodies. Special instruments have been designed

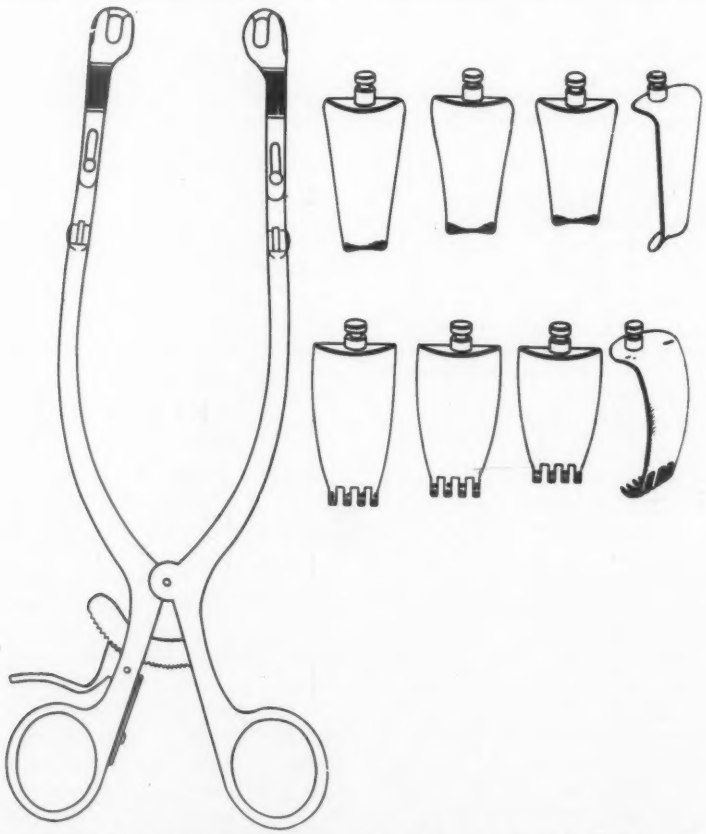

FIG. 1. Self-retaining cervical retractor with blunt and toothed blades of different lengths.

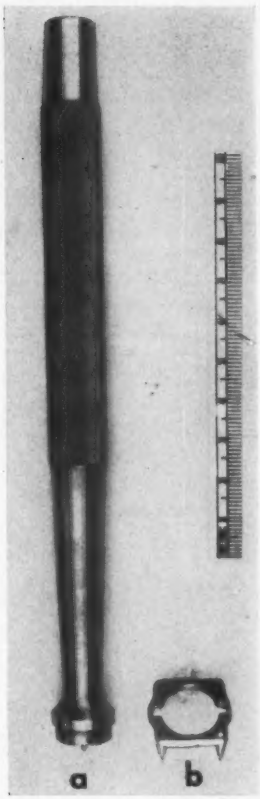

FIG. 2. (*a*), Punch. (*b*), Footplate.

to eliminate hazards and simplify this operation.* The operative technic and use of these instruments will be described herein.

OPERATIVE PROCEDURE

Diagnosis. The diseased disc is first identified by the diagnostic procedure of cervical discography. This has been described elsewhere [2]. Prior to withdrawing the discogram needle, 0.5 cc. of methylene blue dye is injected into the abnormal disc for purposes of identification when the wound is opened.

Anesthetic. The operation is performed upon most patients using local anesthesia and varying amounts of preoperative sedation. Apprehensive patients may require intraveous sodium Pentothal,® but an endotracheal tube is seldom required.

* Manufactured by Codman and Shurtleff, Inc., Boston, Massachusetts.

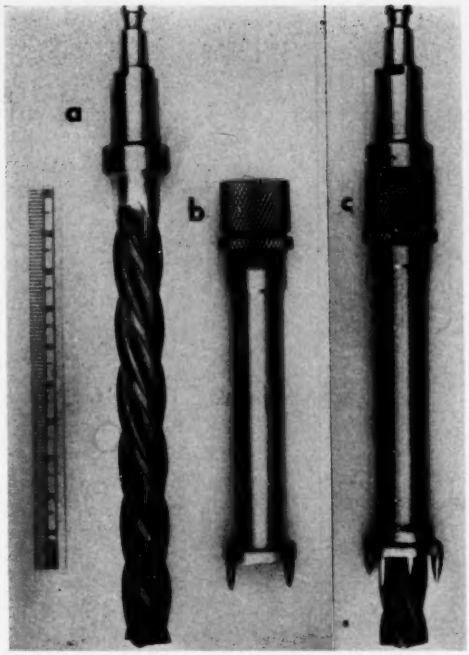

FIG. 3. (*a*), Drill (14 mm. in diameter). (*b*), Straight guard. (*c*), Assembled guard, footplate and drill.

Position. The patient is placed in the supine position with a small sandbag behind the neck. The head is turned to the left, slightly extended and secured to the operating table with a wide strip of adhesive tape.

Draping. Two Mayo stands are placed over the patient in an inverted "V" position, one on the left side of the table over the patient's face, and the other across the table over his chest. A horizontal rod supported by two standards is placed behind the Mayo stands and 2 feet or so above them. The entire area when covered with drapes leaves ample work space for instruments and separates the operative field from the anesthetist.

Incision. The skin incision is made in a normal transverse wrinkle or fold of the neck on the right side at the level of the tip of the thyroid cartilage from the midline to the anterior border of the sternomastoid muscle; it need not be more than 3 cm. long. Subcutaneous tissue is separated from the platysma muscle and retracted vertically with a short-tooth self-retaining retractor. The platysma muscle is split vertically at its medial border.

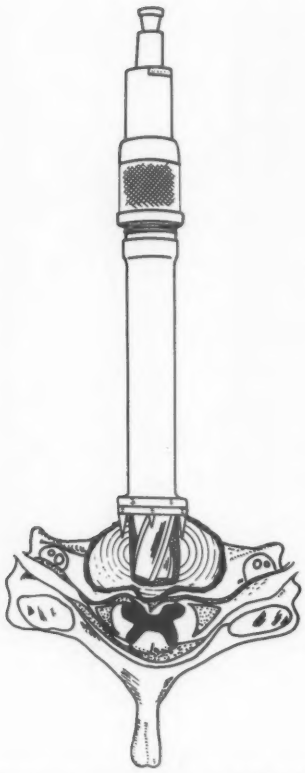

FIG. 4. Sketch shows position of drill hole through center of vertebral body.

The line of cleavage between the lateral border of the thyroid gland and the carotid sheath is opened by blunt dissection with a pair of blunt scissors and continued down to the anterior surface of the vertebra. Two hand retractors with narrow blades facilitate the dissection, some of which may be done with the finger. The self-retaining cervical retractors with blunt blades (Fig. 1) are inserted transverselly, retracting the carotid laterally and the trachea and thyroid medially. Loose areolar tissue is split, removed or retracted, exposing the anterior surface of the spine and the longus colli muscles. The disc is identified by the blue dye. With a small periosteal elevator, attachments of the two longus colli muscles are separated subperiosteally from the vertebral bodies above and below the abnormal disc, the dissection being carried as far lateral as possible. Bleeding encountered at the attachment to the bone is arrested by electrocoagulation. The handle of the self-retaining retractor is turned so that the blunt blades are situated at the upper and lower ends of the wound, retracting it vertically. A second retractor with sharp-tooth blades is inserted to retract the wound transversely. The teeth of the blades are engaged beneath the detached margin of the longus colli muscle on each side and the retractor opened as wide as possible. Injury to structures in the carotid sheath or the trachea and esophagus is unlikely if the retractor teeth are securely engaged beneath the longus colli muscle.

Removal of the Disc and Osteophytes. A long-handle scalpel with a No. 11 blade is used to cut out the anterior half of the (blue) intervertebral disc by running the blade along the adjacent margins of the vertebra. A small curet and a narrow disc rongeur are used to clean the anterior half or two-thirds of the intervertebral space. If osteophytes project from the anterior margins of the vertebra (Fig. 7A), these are removed with a small-end, biting rongeur.

The footplate* (Fig. 2*a*) is attached to the punch. (Fig. 2*b*.) The sharp points of the footplate are placed in the midline equidistant on each side of the interspace so that the hole in the plate is directly over the intervertebral disc. The sharp points are driven into the vertebral bodies by a few sharp blows on the punch. The punch is then removed from the footplate by a half turn counterclockwise. The footplate remains in position attached to the vertebral bodies to hold the guards in place while the drilling is done.

The anterior opening into the spinal canal is made through the vertebral bodies with a ½ inch twist drill (Fig. 3*a*) protected by a guard. The adjustable screw on the end of the guard (Fig. 3*b*) is turned to the last thread and secured there with the locked nut. The guard is engaged in the footplate (Fig. 3*c*) and held firmly in position by an assistant. The cervical drill which is attached to a Hudson drill handle is placed through the guard, and a preliminary hole is drilled in the intervertebral space to a depth of about 1 cm. The drill and guard are then removed to determine the direction of the shallow hole. If the direction is correct, the two halves of the circle will be

* Designed by Drs. Norman Harris and Anthony Smith of Coos Bay, Oregon.

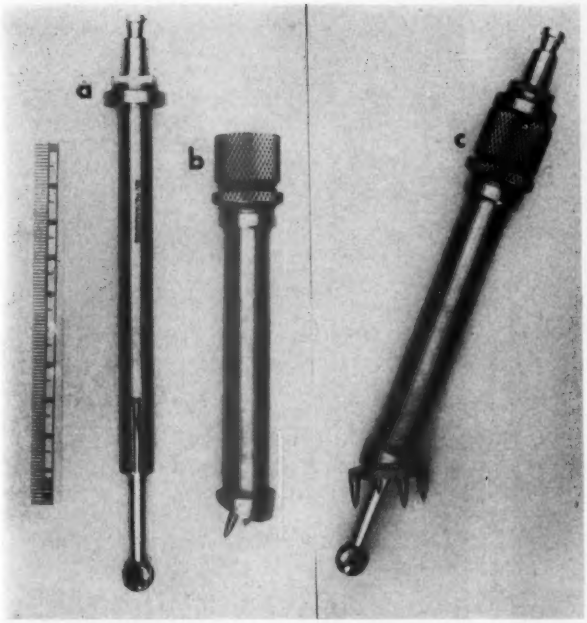

FIG. 5. (*a*), Burr and shaft. (*b*), Angulated guard. (*c*), Assembled guard, footplate and burr.

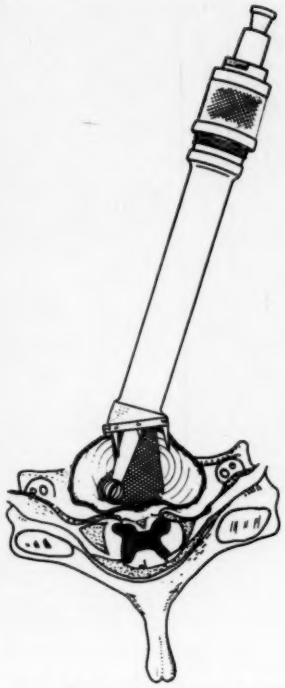

FIG. 6. Drawing shows use of burr to undermine hard osteophytes beneath nerve root.

symmetric in the adjacent vertebral bodies.* If the hole is asymmetric, the direction of the drilling is adjusted by re-engaging the punch with the footplate, tilting it to the proper alignment, and securing it again by a few taps with the mallet. Through the hole in the footplate more of the intervertebral disc is removed with curet and rongeur. The guard is then replaced and the drilling continued in stages until the hard, cortical bone of the posterior surface of the vertebral body is encountered. (Fig. 4.) The drill is advanced 1 or 2 mm. at a time by turning the nut on the guard. Bleeding from the cancellous bone on the sides of the hole is arrested with Gelfoam® and thrombin or bone dust obtained from the bone drill. Bone wax should not be used on the cancellous bone as it interferes with fusion. Bone wax can be used, however, to arrest small arterial bleeders in the cortical bone at the bottom of the hole.

* If two adjacent discs are removed and fused, the drill holes are made asymmetric intentionally. The larger half of the hole for the upper disc is made in the vertebra above and for the lower disc, in the vertebra below. Otherwise the holes may join and the two dowels be in contact.

If the patient's symptoms are unilateral, the angulated guard and burr (Figs. *5a* and *b*) are used. The bone along the posterior margins of the adjacent vertebra beneath the involved nerve root are partially removed with this instrument. (Fig. *5c*.) Bilateral osteophytes in the infraforaminal position are undermined with the burr. The depth of the drilling with the burr is controlled with the adjustable screw on the guard as with the large drill. (Fig. 6.)

The punch is attached to the footplate and with a rocking motion it is disengaged and removed. Bleeding from holes made by the sharp points of the footplate are arrested with bone wax. The thin shell of cortical bone at the bottom of the hole and the posterior margins of the adjacent vertebral bodies are removed cautiously with small sharp mastoid curets and a narrow disc rongeur. The posterior longitudinal ligament is carefully separated from the margins of the vertebra and the latter nibbled out by curetting upward, using the upper margin of the drill hole as a fulcrum.

FIG. 7A. Preoperative roentgenogram of degenerated C5-6 disc.

FIG. 7B. Vertebral body fusion two months after operation.

All bone at the bottom of the drill hole is cleaned out, particularly that in the lateral angles beneath the nerve roots. All osteophyte and disc material herniating into the spinal canal is thus removed without injury to the nerve roots or spinal cord. (Fig. 7B.) Capillary bleeding in the soft tissue at the bottom of the hole is arrested by touching it with a weak

FIG. 8. Arrow points to plugs (or dowels) cut from sterile cadaver ilium.

coagulating current or by packing it with Gelfoam.

Bone Graft. The dowel to be used for the vertebral body fusion is obtained from a bone bank [3] (Fig. 8) or may be secured from the patient's anterior iliac spine by an assistant while the cervical operation is in progress. Through a 3 inch vertical skin incision directly over the anterior iliac spine, the periosteum is stripped from either side of the ilium. The dowel cutter (Fig. 9) is drilled completely through the ilium. The plug obtained has a cortical surface on each end. It is trimmed to a slightly tapered shape, 1.5 to 2 mm. larger in diameter and 2 mm. shorter in length than the depth of the drill hole. Bone dust from the drilling may be packed into the bottom of the drill hole.

Fusion. Prior to inserting the dowel, the patient's head is hyperextended by having an assistant press down forcefully on the forehead. This opens the interspace anteriorly. The dowel is placed in the hole and driven in with the punch until it is flush or slightly below the anterior surface of the vertebral bodies. Absolute hemostasis is necessary before the wound is closed. All capillary oozing from bone and muscle should be completely arrested, using cautery and bone wax. The wound is irrigated with saline and the retractors removed. A small rubber tissue drain is placed down to the bone. Muscles are approximated with loose catgut sutures. Careful attention to skin closure using fine silk for subcutaneous and superficial sutures will result in an almost invisible scar. The drain is removed in twenty-four hours and the drain hole in the skin is closed with a single suture which was previously placed but left untied.

Postoperative Care. The patient is permitted out of bed the day following the operation. The slight amount of pain is readily controlled with aspirin. Skin sutures are removed in twenty-four to forty-eight hours. No cast, neck brace or cervical collar is required or advised. The pain in the neck, shoulder and arm is relieved almost immediately. The patient may be discharged from the hospital on or before the third or fourth postoperative day. Roentgenograms are taken prior to discharge. The patient is frequently able to return to a sedentary occupation within one week and heavy work one month after discharge from the hospital. Fusion of the vertebral bodies will occur within six to eight weeks.

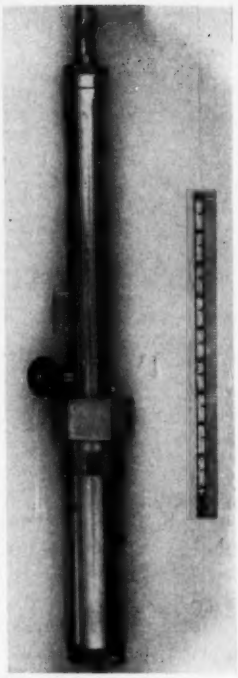

FIG. 9. Dowel cutter.

SUMMARY

A brief description is given of the operative technic and the instruments used in the new operation of vertebral body fusion for ruptured cervical discs by an anterior approach.

In the past two years this operation has been used on eighty-four patients from whom one or more cervical discs were removed and the vertebral bodies fused. Fusion occurred in eighty-one patients with complete relief of pain in the neck, shoulder and upper extremities.

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A Gastric Anastomotic Clamp

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From the Departments of Surgery, The Ohio State University and Mount Carmel Hospital, Columbus, Ohio.

No gastric anastomotic clamp lends itself to all situations. The anatomy of the stomach makes the use of delicate instruments an impracticality, since the organ is thick-walled and vascular. The conventional clamps, that will control bleeding from the gastric wall and will not slip, are usually crushing instruments. Generally, a second non-crushing instrument is placed proximally to the resection line to control the bleeding and prevent spillage of stomach contents. Our experience with such instruments has been unsatisfactory in that they do not hold.

CONSTRUCTION

Figure 1 illustrates a three-bladed, non-crushing instrument.* It is 14 cm. in length and 7 cm. in width. The outer blades are held at either end by threaded bolts and can be moved toward the middle blade by tightening the lateral nuts. All the blade surfaces have Atraumatic® teeth. The center blade is pierced by and rotates about one of the bolts. Its other end has a pin which locks into the center of the opposite bolt. The clamp is a one-piece instrument that eliminates the hazard of the loss of parts.

* Instrument is manufactured by the G. P. Pilling & Son Company, Philadelphia, Pennsylvania.

USE

The stomach is mobilized and incised from the duodenum in the usual manner. The distal, incised end of the stomach, which is held by a crushing clamp, is passed through the instrument. (Fig. 2A.)

The middle blade is rotated in and is locked to the center piece of the opposite bolt. The stomach is pulled up so that the resection stays 1½ inches above the instrument level. (Fig. 2B.)

The stomach is now clamped into position by tightening the lateral nuts evenly and the

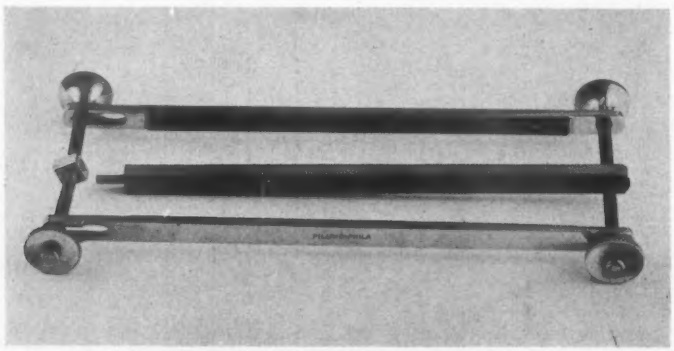


FIG. 1. Photograph of instrument.

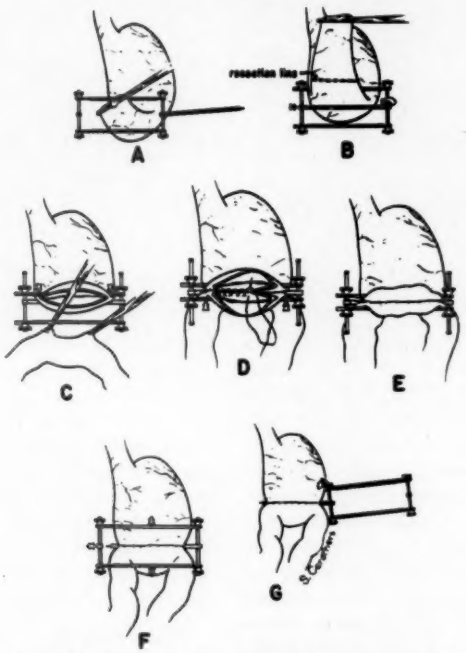


FIG. 2. A, incised part of stomach is placed into position. B, middle blade is positioned. C, stomach is clamped. Jejunum is brought into position. D, jejunum is clamped and the anastomosis is made. E, anastomosis is completed. F, lateral blade is opened, middle blade is unlocked. G, instrument is removed.

stomach is transected. The jejunum is pulled through the other half of the clamp. (Fig. 2C.)

The jejunum is clamped by tightening the lateral nuts. The anastomosis is performed as preferred. (Fig. 2D.)

The anastomosis is then completed. (Fig. 2E.)

The lateral blades are then opened and the middle blade unlocked. (Fig. 2F.) The lateral blades are rotated, and the middle blade is pulled out gently from behind the anastomosis. (Fig. 2G.)

CONCLUSION

An Atraumatic, anastomotic gastric clamp is presented. We believe this instrument lends itself to most anastomoses of the gastrointestinal tract.

A Rotatable, Lighted Anoscope for Complete Anorectal Evaluation

DANIEL J. ABRAMSON, M.D., *Washington, D. C.*

IN order to eliminate multiple insertions and to provide a more adequate view of the anorectal area, a new anoscope was described in 1956. The speculum was designed to provide, in one instrument, the type of views permitted by the standard anoscopes currently in use. Because of the multiple views, proper evaluation of the anorectal condition is permitted. Rotatability of the speculum was added to facilitate examination, making only one insertion necessary. All contact edges were rounded to avoid traumatism to the anal mucosa when the instrument was rotated. In the original design, rotation was accomplished by turning three protruding phalanges; however, an improved method of turning (see description) has been substituted, making rotation a simple and uncomplicated procedure. Lighting features have also been added.

Examination with the anoscope* is accomplished rapidly with the patient in the knee-chest, lateral Sims, or lithotomy positions. Hemorrhoids can be graded by the amount of tissue protruding through the slotted area. The instrument is also useful in the injection treatment of hemorrhoids and in other forms of minor anorectal surgery. The entire anoscope, including the light carrier and lamp, can be sterilized by autoclaving or boiling, and is assembled or disassembled easily.

* Manufactured by Welch Allyn, Inc., Skaneateles Falls, New York.

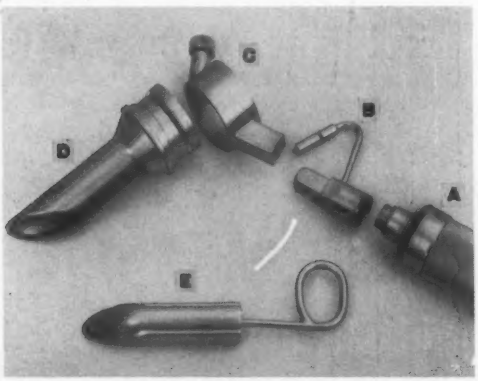


FIG. 1. The component parts of the anoscope are demonstrated. These are (A) the battery handle, (B) the offset light carrier, (C) ring with rotating mechanism, (D) the speculum and (E) the obturator.

DESCRIPTION

The component parts of the instrument are seen in Figure 1. Figure 1A and B show the battery handle and the light carrier which provide necessary illumination.

Figure 1C shows the ring which attaches to the light carrier (B) and receives the speculum (D). An external knob and the internal gear are located in the superior portion of the ring. The latter engages with the gear of the speculum, and, when the knob is turned, the speculum rotates through 360 degrees. A magnified view of the gear arrangement in the ring and speculum is seen in Figure 2.

The speculum (D) is snapped into place and is removed by elevating the knob. The intermediate portion is cut out and the tip bevelled to allow composite views of the anorectal area. All edges are rounded so that trauma to the mucosa (on rotation) is avoided. The obturator (E) is removed after insertion of the speculum. It is cylindrical and the tip is bevelled to fit into the corresponding portion of the speculum. The sides are grooved and the rolled edges of the speculum fit into these grooves. The assembled instrument is seen in Figure 3.

TECHNIC OF EXAMINATION

1. The lubricated speculum and obturator is inserted into the anus; the obturator is removed.

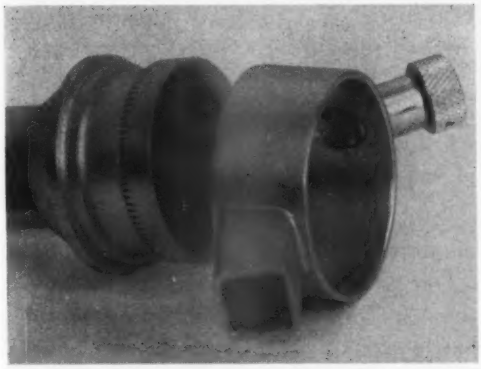


FIG. 2. View of the speculum and ring demonstrating the pinion and gear arrangement and the rotating mechanism.

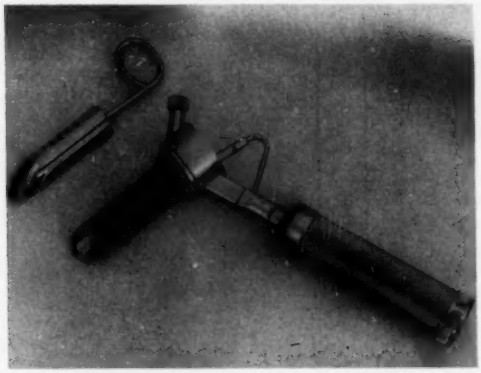


FIG. 3. The assembled anoscope is demonstrated. The obturator has not been inserted.

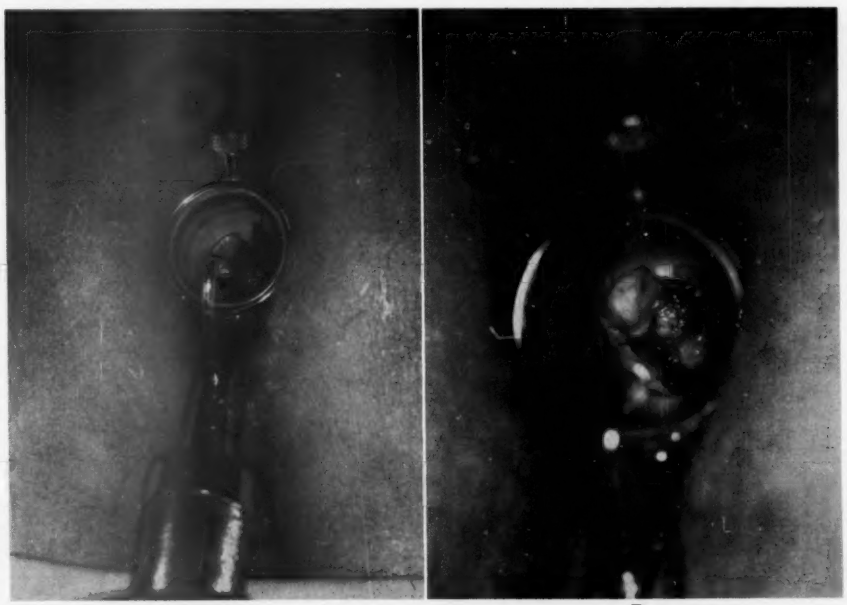
2. The light is turned on and forward inspection through the terminal end of the instrument is accomplished.

3. Examination through the slotted area and of the perianal skin follows.

4. Another view is obtained by partially withdrawing the instrument. The bevelled tip is depressed against the anal mucosa.

5. The instrument is returned to the position of full insertion, rotated very slowly to the next section by turning the knob. The entire circumference is examined.

An alternative method of examination is accomplished by inserting the speculum to the half-way position, removing the obturator and turning on the light. The tip is then depressed against the anal mucosa. The speculum is rotated slowly around the entire circumference.



4A 4B

FIG. 4. A, the anoscope inserted. B, close-up view of the same patient demonstrating anorectal polyps.

Visualization of anorectal polyps with the instrument is shown in Figure 4.

SUMMARY

A new, rotatable, lighted anoscope that offers an extremely wide variety of views of the anorectal area has been described. Incorporated in one instrument, are the desirable features of various types of existing anoscopes. Only one insertion of the anoscope is necessary. All contact edges have been rolled to avoid traumatizing the anal mucosa. A new type of rotating device, utilizing a pinion and gear arrangement is presented. The instrument is assembled or disassembled easily. The speculum and light carrier can be sterilized by autoclaving or boiling.

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A Tracheal "Hocker" Valve

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THE instrument described herein is a simple one-way breathing valve which can be attached to a tracheotomy cannula for the purpose of allowing inspiration through the tracheostomy and expiration through the trachea and larynx.

When a tracheotomy tube is of a proper size, it is possible to "stopper" the tube prior to its removal, allowing the patient a period of re-education in clearing secretions from the oropharynx and permitting him to vocalize. Certain patients have difficulty in this transitional period. They may be apprehensive about resuming a normal exchange through the pharynx, larynx and trachea, or they may actually be unable to do so because of difficulty in coughing up or swallowing pharyngeal secretions. The incorporation of a simple, removable, one-way breathing valve into the tracheostomy tube allows unobstructed inspiration and an opportunity to expire via normal passageways, permitting training in the handling of secretions, coughing and vocalizing. The last factor may be extremely important in maintaining morale in a patient who is subjected to tracheostomy for a prolonged period.

The foregoing is one method of achieving this desired respiratory cycle. It incorporates a simple flutter-valve in a removable housing which can be easily removed from a standard tracheotomy "inner tube" allowing all parts

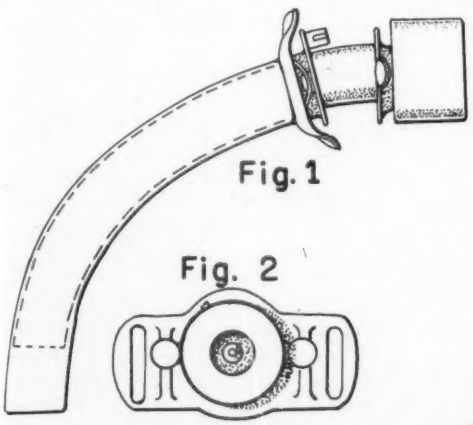
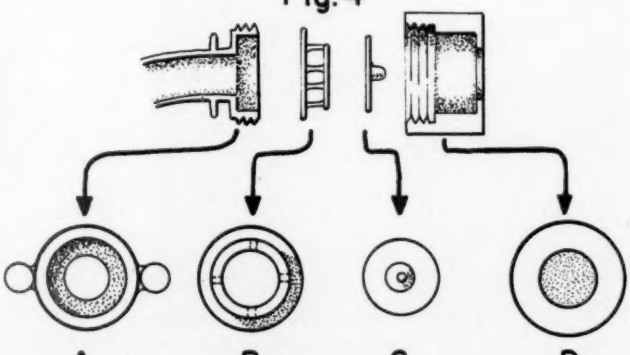


Fig. 1

Fig. 3

Fig. 2

Fig. 4



to be brushed and sterilized; however, any one-way valve arrangement will serve the purpose.

Figures 1 and 2 are side and front views respectively of a standard tracheotomy tube with an attached one-way "hocker" valve.* Figure 3 is a line drawing of the component parts of such a valve, in this instance employing a flutter-valve principle. Figure 4A is a side and end view of a screw attachment for a standard tracheotomy inner-tube. Figure 4B represents similar views of a fluted washer designed to allow circulation of air around (4C) a teflon diaphragm. Figure 4D is a side and end view of the outer housing for the component parts. This housing is joined to the tracheal inner-tube by the illustrated threads. In addition, the diameter of the terminal port of this housing corresponds to the diameter of the raised ring on the fluted washer, allowing optimal circulation of air through the latter no matter how the sealing diaphragm falls against said washer or entry port.

In summary, a simple, one-way breathing valve is herein described, which may be attached to a standard, well fitted tracheotomy cannula allowing inspiration via the tracheostomy and permitting expiration through the normal passages (i.e., trachea, larynx and pharynx).

Acknowledgment: I wish to thank Dr. Joseph Ransohoff for his support.

* Pilot model made by Alex Halis and Frederick Sellmer, New York.

Acute Compression of the Mediastinum by a Hematoma

YOUSIF D. AL-NAAMAN, M.D., *New York, New York*

CHRONIC hemomediastinum or mediastinal hematoma is a well known entity, although it has been relatively rare. The incidence of this condition should increase in proportion to the increase in automobile accidents; however, one reason for the lack of reports of such cases might be the fact that roentgenograms of the chest in cases of trauma are usually taken with the "Bucky" technic.

Endress [4] reported two cases of mediastinal hematoma. Prior to this time he had not encountered such an entity; consequently, a diagnosis of lymphoma of the mediastinum was made even though the history of trauma was known.

There are two other isolated case reports by Duyster [2] and Schmitt [9]. Horn [6] reported a case of mediastinal hematoma resulting from a stab wound of the internal mammary artery. Vincent [12] and associates have reported a fatal case of hemomediastinum in a twelve year old child who fell 50 meters into a lake. Death supervened forty-eight hours after injury, and autopsy revealed a huge mediastinal hematoma. Perez-Fontana [8] and associates reported a case of ruptured aortic aneurysm involving the mediastinum and neck. Townsend [11] and, Duperrat and Ullmann [3] reported single instances of hematoma of the mediastinum from rupture of aortic aneurysms or dissecting aneurysms, and Golden [5] reported that mediastinal hematoma is usually brought about by rupture of one of the great vessels in the neck with the blood gravitating downward to the mediastinum. He also stated that if much blood accumulates it is possible that the pleura will tear, thus freeing the blood to enter the pleural space. Recently Laforet [7] reported a case of traumatic hemomediastinum with subsequent recovery.

Among not more than fifty reported cases of mediastinal hematoma, few patients have died in an acute phase. These acute cases of massive mediastinal hematomas are the nidus on which this paper has been written to emphasize certain facts about mediastinal compression.

CASE REPORT

A twenty-five year old Latin American man was admitted to the Emergency Room of Jefferson Da-

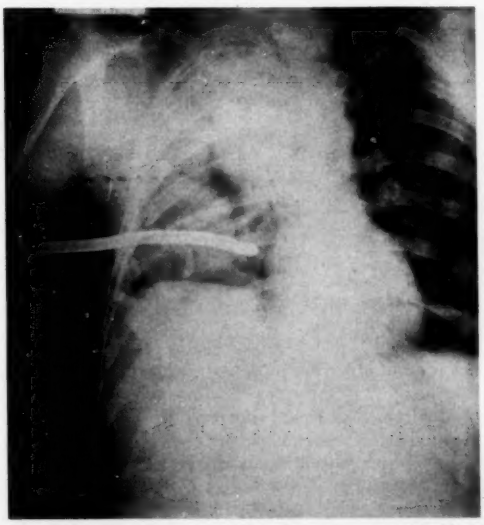


FIG. 1. Roentgenogram of the chest shows mediastinal hematoma with hemothorax.

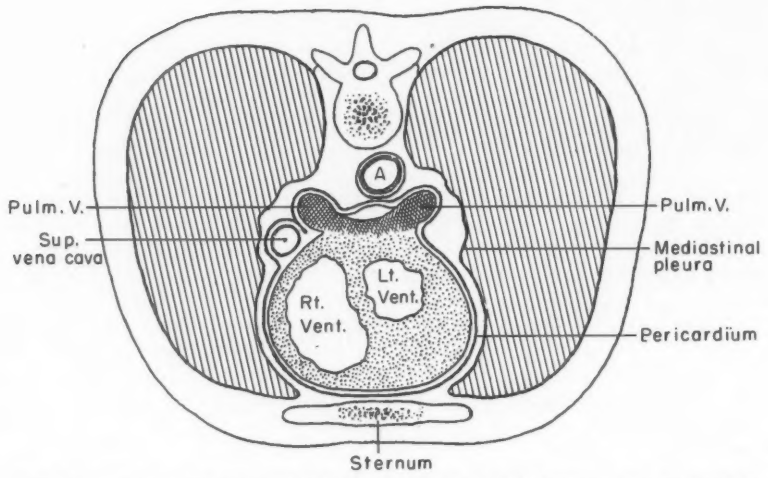


FIG. 2. Transverse section through the heart at the level of the intracardiac portion of the pulmonary veins.

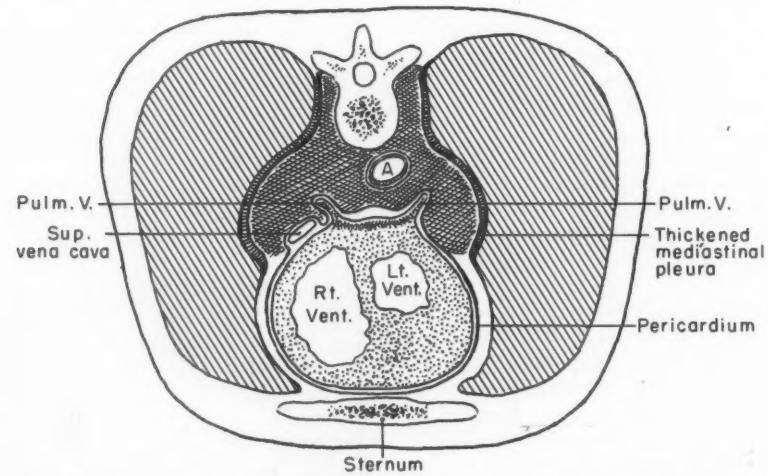


FIG. 3. Acute mediastinal hematoma compressing pulmonary veins and superior vena cava.

vis Hospital, Houston, Texas, on July 22, 1955, with a stab wound in the second intercostal space just to the right of the sternal border. Blood pressure was 60/40 mm. Hg, pulse 110, and respiration 35. There was some respiratory embarrassment. Three units of blood were administered in the Emergency Room with a chest catheter connected to underwater drainage removing about 800 cc. of blood from the chest. The blood pressure was raised to 100/70 mm. Hg, and the patient responded well. A roentgenogram of the chest showed a hemothorax with a mediastinal hematoma. (Fig. 1.)

After the administration of the fourth unit of blood was begun, the patient was transferred to the ward. At this time his vital signs were relatively stable, but two hours later he became restless, cyanotic and dyspneic and suddenly died.

Findings at autopsy were as follows: (1) right hemothorax with a massive mediastinal hematoma, (2) laceration of the right pulmonary artery, and (3) old pulmonary adhesions.

In reviewing the history of the patient, it was revealed that he had sustained a similar injury to the right side of the chest in 1951 with hemothorax.

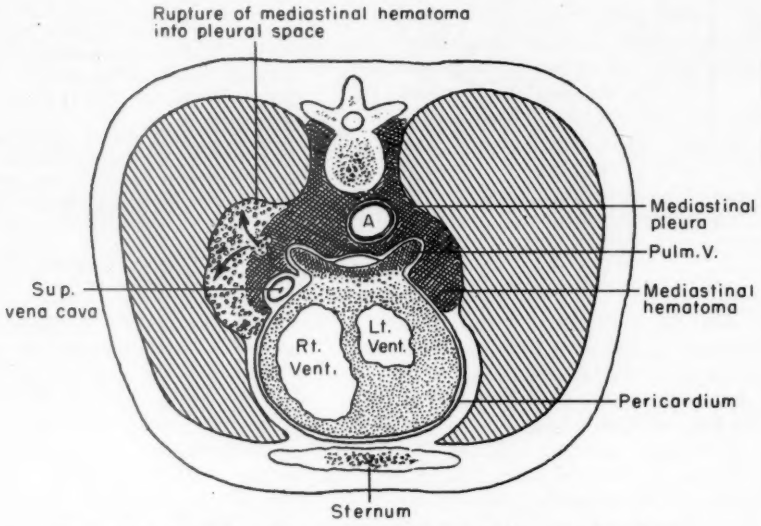


FIG. 4. Decompression of the mediastinal hematoma into the pleural space.

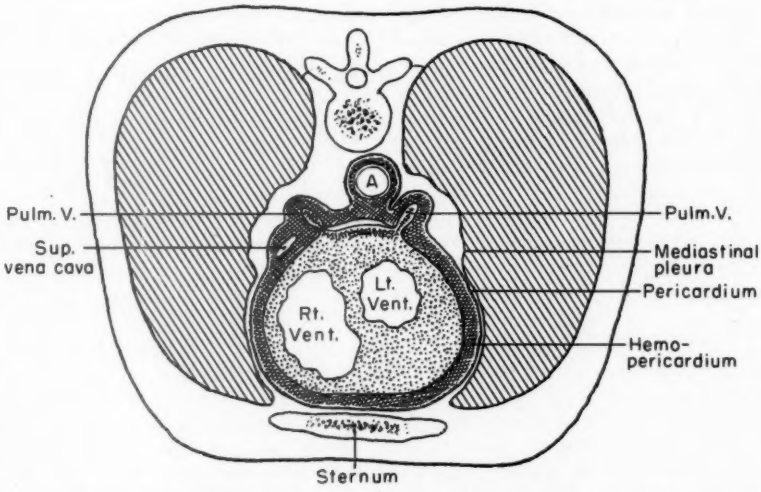


FIG. 5. Hemopericardium compressing pulmonary veins and venous flow.

At that time he was treated by thoracentesis, the administration of antibiotics and the instillations of enzymes.

COMMENTS

By the precise nature and factors involved in the mechanism of acute mediastinal compression certain facts have been established which not only have a fundamental pathologic significance but also appear to have a definite relation to certain clinical conditions. In this case the lost blood was replaced with consideration of the loss in the mediastinal space. Normally (Fig. 2), the mediastinal pleura is thin. The presence of pulmonary adhesions due to the subject's previous trauma had added rigidity to his mediastinal pleura (Fig. 3) and prevented the possibility of spontaneous decompression into the pleural cavity (Fig. 4), thus resulting in a tamponade of the cardiac inflow extrapericardially (Fig. 3) in contradistinction to the intrapericardial tamponade.

(Fig. 5.) Also, a neurogenic factor, in combination with the tamponade, causing sudden alteration of cardiopulmonary dynamics might be added as a complex to the fatal mechanism. The clinical features and symptomatology mimic that of cardiac tamponade. (Fig. 5.) Although the treatment might be different initially, it seems that immediate thoracotomy with decompression of the mediastinum is the procedure of choice.

SUMMARY

1. A case of acute mediastinal compression causing tamponade of the cardiac inflow with fatal termination is presented. The term extrapericardial tamponade was used in contradistinction to the intrapericardial tamponade known as cardiac tamponade.

2. The condition is more apt to occur in patients in whom the mediastinal pleura resists the mediastinal pressure due to enforcement by adhesions and the reaction of fibrous tissue from a previous trauma or inflammatory process.

3. The clinical picture and treatment of the condition have been commented upon.

Acknowledgment: I wish to thank Dr. M. E. DeBakey for his permission to report this case.

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The Conservative Management of Dermoid Cysts Involving Both Ovaries

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CONSERVATION of ovarian tissue in young patients should be strongly considered during surgery, especially, if a pathologic condition involving both ovaries is found. Reports in the literature have demonstrated this fact time and again. The only risk involved, when the disorder is of a benign nature, is that there may be a recurrence of the same condition or dysfunction of the ovaries which will result in more surgery at a future date. Since one cannot foretell with any accuracy if a pathologic condition will develop and since the chance of additional surgery is slight anyway, it is worthwhile indicating to the patient that the procedure is of value for various reasons. She can be told that during the succeeding period, she will be practically free of those symptoms which usually develop beginning five or six weeks after bilateral oophorectomy. It is true that some patients suffer little from artificial menopause, but the largest percentage do have symptoms and these should be avoided, for their comfort, as long as possible. In addition, many young married women experience, after removal of both ovaries, a dryness of the vagina which interferes with sexual relations and in fact makes intercourse difficult for many of them. This symptom alone is worth avoiding in order not to upset existing domestic tranquility.

With much investigation while preparing material for a paper [*1*] in 1939, I was not able to find many articles in the literature pertaining to the conservation of ovarian tissue. Some authors [*2–6*] had evaluated the role of the ovary in chronic pelvic inflammation, endometriosis and some benign ovarian lesions and had suggested that salvage of portions of the ovaries so involved could and would be of value to the patient. Interest in the possibility of salvaging some portions of bilateral ovarian dermoids arose from two patients under my care at about the same time, who continued to have normal and regular menstrual periods despite the presence of very large, bilateral, ovarian, dermoid cysts. It seemed if some normal tissue could be found and saved that periods ought to continue on the previous regular schedule with the further possibility that pregnancy might also occur. At that time, besides reviewing the literature, I questioned many prominent surgeons and gynecologists associated with the various medical schools in the Boston area and found only one who said he had attempted to salvage normal ovarian tissue from bilateral ovarian dermoids. Consequently, salvage was attempted and proved to be successful. Since ample references could be found advising the removal of both ovaries when bilateral ovarian dermoid cysts were found and since conservation had proved successful in other cases, attention [*7*] was again drawn to the satisfactory results obtained. This paper received the following favorable comment from the editor, Henry M. Harkins, of the *Quarterly Review of Surgery* [*8*]. "This is a welcome paper and it is hoped that more papers stressing conservatism in removing ovarian tissue will be forthcoming. The widespread sacrifices of ovaries and tubes going on in this country can be alleviated only by persistent propaganda of which the above report is an excellent example."

One patient was followed-up for eleven years after salvage of a ten-cent size piece of tissue from bilateral ovarian dermoid cysts. This case was reported [*9*] because the patient subsequent to the surgery was delivered of three healthy, well-formed babies and because a large dermoid cyst re-formed at a later date from the small salvaged portion. In the interim, up to age forty, this patient was free of menopausal symptoms.

Novak [*10*] in reviewing this paper, made the

following comment. "The author's two cases are meant first of all to emphasize the value of conservation of ovarian tissue in young patients, even with bilateral dermoids, and there will not be much disagreement on this point . . . Even if the conserved ovary or portion of ovary seems entirely normal, there is always a slight theoretical chance of later dermoid development, but the numerical incidents of such an occurrence is so slight that it should not deter one from the conservative plan."

Other authors [*11–15*] have recommended bisection of the dermoid cyst in search of normal tissue. In my two cases normal tissue was found more prominently displayed in the left ovary near the junction of the ligament and contained vessels. The ovaries were nearly as large as oranges and the portion salvaged was no larger than a ten-cent piece.

The purpose of the present paper is again to bring attention to the fact that conservation of portions of the ovary during surgery is not difficult and that the presence of a very small amount of ovarian tissue will protect the patient's future well-being. Studies have been made [*16*] indicating that carcinoma infrequently develops in ovarian dermoid cysts. Therefore, one hardly need consider this possibility too strongly as a reason for not performing the conservative procedure. The following case is of interest for the various reasons already given.

CASE REPORT

On June 24, 1957, nearly total bilateral resection of both ovaries and oophoroplasty was performed on a thirty-five year old unmarried woman (Booth Memorial Hospital, Boston). The right ovary was about the size of a golf ball and from the right side there projected a simple cyst about one and a half times the size of a marble. Practically all of the ovary was resected, leaving a very thin portion of ovarian tissue in the capsule along the ligamentous margin. The ovary was removed without rupture. The cut edges were then approximated by a number of interrupted mattress sutures. About six or seven such sutures were required and bleeding was well controlled. The left ovary was about the size of a small peach. The capsule was thick. There appeared to be some normal tissue at the lateral margin and the line of resection was carried out beginning at this point and continued toward the mid-line. The left ovary was also removed without rupture and the cut edges of this remnant were approximated by interrupted stitches. Bleeding was well controlled.

The pathological description was as follows: The left ovary was large, round, smooth and incompletely resected. It measured 4.5 by 4.7 by 4.0 cm. The surface was smooth, greyish white and glistening. The area which had been resected measured 4.8 by 2.5 cm. and the surface was rougher and slightly more greyish brown in color; it was not smooth or glistening. On sectioning of this ovoid mass it was found to be cystic and contained a great deal of black hair and a yellowish white fatty material which was semi-solid in consistency. The wall of the cystic mass measured 0.1 cm. in thickness except at one point near the resected margin where the wall measured 0.8 cm. in thickness; included in this 0.8 cm. was a small cyst measuring 0.4 cm. in diameter which contained more yellow gelatinous material. On examination of the homogeneous yellowish white material which was infiltrated with hair, no other epidermal structures were found. There was a small hillock which rose from one wall of the cystic cavity and extended into the cavity for a distance of 0.8 cm. It was firm, whitish on cut section and had hair growing from the surface. There was no calcium felt in the hillock and a section was made through this area.

The right ovary measured 6.0 by 3.7 by 3.5 cm. It was large, round, smooth and glistening on all surfaces except for its resected margin. This resected bare area measured 5.0 by 2.5 cm. and was slightly greyer in color; it had a rougher surface with pieces of tissue adhering to it so that it was not glistening. On sectioning there was seen a small band of ovarian tissue measuring 1.0 by 2.0 cm. There were three small cysts in this area, the largest measuring 0.5 cm., the smallest 0.3 cm. in diameter. These three small cysts which were recognizable in the ovarian tissue had smooth surfaces which were yellow-white and glistening and contained clear colorless fluid. On one side of the recognizable ovarian tissue was a large cystic cavity measuring 2.5 cm. in diameter. It had a smooth, white glistening wall which measured 0.2 cm. in thickness and contained a yellowish white gelatinous fluid which appeared quite fatty. At the bottom of this yellowish white fatty gelatinous mass there was a hillock which was calcified and had the appearance of a tooth. It measured 1.0 cm. across its base. On the other side of the band of recognizable ovarian tissue there was a cyst, 1.5 cm. in diameter. It had a glistening yellowish white surface and on section it contained a clear colorless fluid.

The final diagnosis was subtotally resected ovaries, each showing an intact dermoid cyst. There was no evidence of malignancy.*

The photographs taken of the specimens (Fig. 1) clearly indicate how little tissue was permitted to remain on each side; yet, this was of sufficient size

* Pathologist was Dr. J. T. Giammalvo.

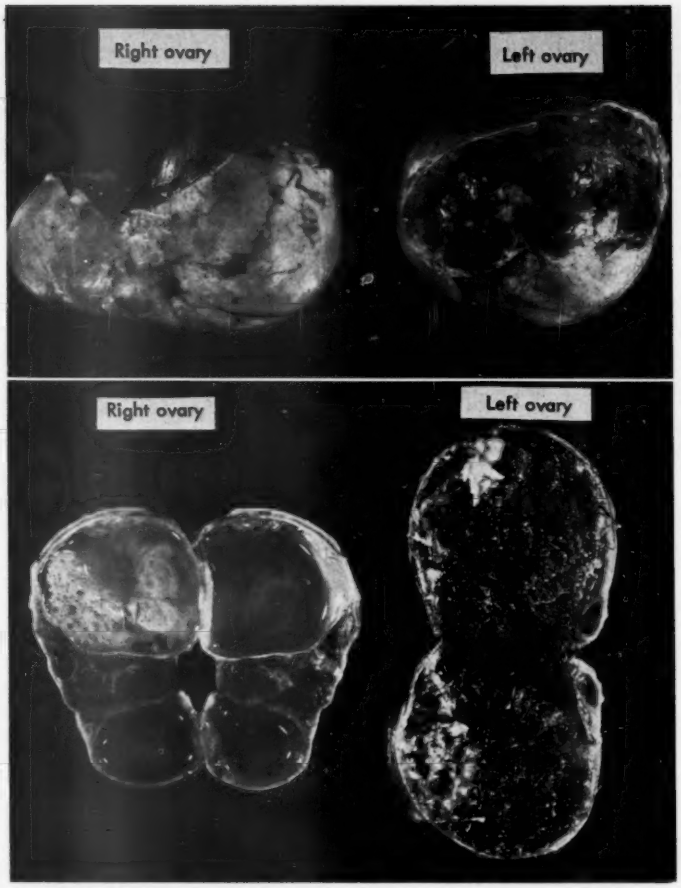

FIG. 1. Right ovary. Resected bare area is 5.0 by 2.5 by 0.1 cm. in thickness. Cysts and hillocks are prominently seen. Left ovary contains hair. Resected bare area is 4.8 by 2.5 by 0.8 cm. in thickness.

to give adequate functional activity so far as regularity of periods has been concerned. This patient's case has been followed-up at regular intervals for nearly eighteen months (at this writing). There is no evidence of any abnormal change that can be determined on pelvic examination. Since this patient is still unmarried, no definite statement can be made as to the presence or absence of ovulation without further extensive studies or pregnancy intervening.

COMMENTS

That conservative ovarian surgery can be practiced with great benefits to many women in the presence of benign ovarian disorders is a foregone conclusion. This fact has been reported time and again by various authors who have urged the salvage of a portion of an ovary in cases of chronic pelvic inflammation, endometriosis, ovarian dermoid cysts and other benign lesions. Such patients have not suffered sudden surgical menopause and have had the opportunity of becoming pregnant. This paper, therefore, is written as a suggestion that the surgeon consider carefully his decision to remove the ovaries and that, because of the severe consequences from bilateral oophorectomy, he preserve, in young women especially, as much ovarian tissues as possible.

SUMMARY

Reference has been made to reports of conservative ovarian surgery in the presence of bilateral ovarian dermoids. It is pointed out

that the salvage of exceedingly small pieces of ovarian tissue has protected the patient against sudden surgical menopause and that in this case very small pieces of tissue have been adequate to produce normal periods.

I have practiced conservative ovarian surgery in a large number of women requiring surgery during the past thirty years and the results have been satisfactory.

This paper deals specifically with the treatment of bilateral ovarian dermoid cysts because it is still not unusual practice for surgeons to remove both ovaries when these are found. Such surgery frequently is not warranted. Emphasis, therefore, is placed on the fact that conservative ovarian surgery is possible and ultimately is of great benefit to those few patients who have ovarian dermoids.

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Broken Thermometer Bulb Penetrating the Submaxillary Duct

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CONSIDERING the concern which follows the not infrequent breakage of a thermometer in a child's mouth, and the stories told of the dire consequences, it is amazing that a survey of the medical literature has failed to reveal a single report of related serious injury. The following case is reported because of its unusual nature and as a reminder that ostensibly minor injuries are not always as innocuous as they first appear. It also demonstrates that a mass presenting spontaneously in the upper part of the neck may represent reaction to foreign material introduced through the floor of the mouth.

CASE REPORT

A lump developed in the neck of a nine year old girl and was noticed for about one month. The mass had been steadily enlarging and the overlying skin had become discolored. It was not painful and had never drained. No other symptoms related to the head and neck were at first obtained. The results of a systemic review were completely normal. The past medical history revealed that the child had had no previous serious illnesses and no surgery except for adenotonsillectomy when she was three years old. The parents were well and of Mexican extraction. The child's siblings were entirely normal and there was no history of familial disease.

The physical examination disclosed a well developed, preadolescent child on whom the examination of the head, eyes, ears and nose was normal. Bulging slightly to the right of the midline at the hyoid level in the neck anteriorly, was a globular mass, 1.5 cm. in diameter. The overlying skin was violaceous but there was no local heat or tenderness. Palpation revealed the lesion to have a homogenous, spongy consistency with some deep fixation. The right submaxillary gland was firm, enlarged, moderately tender and separate from the superficial mass. Bimanual palpation with a finger in the floor of the mouth disclosed fixation of the gland to the oral mucosa. The left submaxillary gland was palpable, soft, and normal in size and consistency. There were no palpable cervical lymph nodes. Within the mouth the salivary duct orifices appeared normal. The right submaxillary duct was examined carefully and saliva appeared at its orifice with no evidence of inflammation about the orifice. The teeth were in good condition and the tonsils were absent. The remainder of the physical examination was normal.

It was our clinical impression that the findings represented two unrelated diseases: a thyroglossal cyst and a tumor or chronic inflammatory lesion of the right submaxillary gland.

The results of a blood count and urinalysis were entirely normal. Roentgenograms of the neck and submaxillary area were not obtained. Because of the nature of both lesions, exploratory surgery was advised and carried out.

At surgery a transverse elliptical incision was made surrounding the cutaneous tumor mass and carried through the platysma level. Deep to the platysma extending from the right superior aspect of the mass, a well defined sinus tract was encountered. The tract unexpectedly extended laterally to the right and entered the hilum of the enlarged right submaxillary gland. This gland was surrounded by dense, inflammatory tissue and at its hilum a hard nodular area was encountered. While dissecting the hilum, a few metallic fragments were uncovered. It was thought that they were mercury but we were not certain. The submaxillary duct and vascular supply were ligated and the gland was removed. The single specimen excised consisted of the cutaneous lesion, its sinus tract and the right submaxillary gland.

Pathologic examination of the fresh specimen revealed a firm, enlarged submaxillary gland with a very hard 6 mm. area at its hilum from which extended an attached sinus tract leading to a small ovoid of skin and subcutaneous tissue. (Fig. 1.) Because of the metallic fragments encountered dur-

* The pathologic examination of the specimen was performed in the Pathology Department, Mercy Hospital, San Diego, California by Dr. D. A. DeSanto.

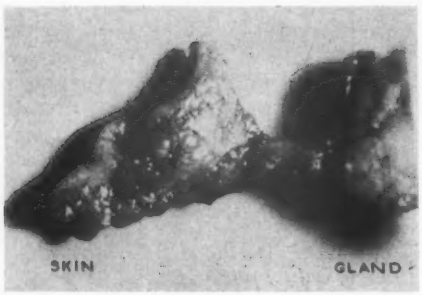

FIG. 1. A photograph of the intact specimen. The sinus tract is easily distinguished connecting the skin and gland.

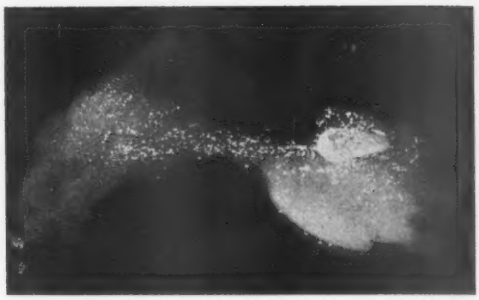

FIG. 2. This radiograph of the intact specimen demonstrates the fine scatter of mercury particles throughout the gland parenchyma, along the sinus tract, and into the cystic cutaneous lesion. One can outline the glass thermometer bulb, containing some mercury, in the upper central zone of the gland.

ing the dissection, we obtained an x-ray film of the specimen, suspecting a foreign body. The roentgenogram disclosed a fine scatter of metallic particles throughout the substance of the gland, along the sinus tract, and into the cutaneous lesion. (Fig. 2.) Transecting the tissues adjacent to the hilum released the bulbous glass tip of a rectal type thermometer, still containing a small amount of mercury.

In the microscopic sections of the submaxillary gland, there were numerous large and small metallic particles scattered throughout. The larger particles were surrounded by a foreign body type of granuloma. (Fig. 3.) Interstitial fibrosis and lymphocytic inflammatory infiltration replaced much of the parenchyma of the gland. A dense, inflammatory reaction consisting of granulation tissue, infiltrated with histiocytes, giant cells, lymphocytes and polymorphonuclear leukocytes containing a scattering of metallic fragments, surrounded the sinus tract and the cutaneous lesion which grossly had contained a cystic core.

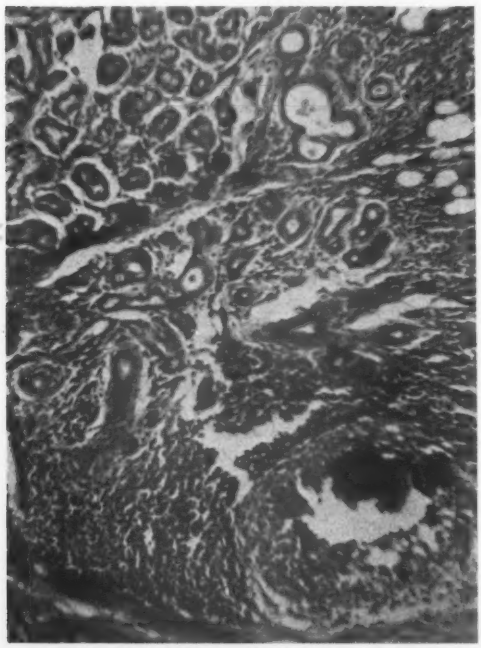

FIG. 3. A particle of mercury in the gland parenchyma, surrounded by dense inflammatory response. Hematoxylin and eosin stain.

The size of the metallic particles precluded their being transported by phagocytes and it is postulated that the mercury had spread from the bulb into the gland by means of a rent in the ductal system, and through the tissues of the neck into the subcutaneous cyst.

On further questioning, postoperatively, the parents stated that a thermometer had broken in the child's mouth approximately two and a half years before and that the child had expectorated a small amount of blood at the time. They had examined the child's mouth and had seen no evidence of injury. About one year after the accident the child complained of soreness in the right submaxillary region, and the parents could feel a small lump. She was examined by two physicians who reassured the parents and advised no further treatment. Since then, slight intermittent cervical tenderness had persisted prior to the development of the superficial tumor.

COMMENTS

Apparently the thermometer bulb penetrated the submaxillary duct at the hilum of the gland and was retained there after the thermometer broke. It is inconceivable that the bulb tip had migrated along the duct or that the rectal thermometer had been placed within the orifice of the duct. That mercury had been expelled

into the lumen of the duct, at least in part, is quite evident by the unusual scatter of mercury particles throughout the gland. It is of interest that the mercury rather than being extruded into the mouth through the orifice of the duct migrated, probably influenced by gravity, to the skin as well as into the gland parenchyma. In spite of the inflammatory process, the duct distal to the sinus was intact and the gland was functioning.

While the involvement of the submaxillary gland represents a rare and curious coincidence, the breakage of a thermometer and penetration of the broken tip through the floor of the mouth must occasionally occur. Because of the course of events in this case, one can speculate that in some instances migration of the mercury back into the mouth would not occur, blocked by its tough mucous membrane. The mercury might instead migrate under the influence of gravity into the upper part of the neck and present as a tumor which could easily be mistaken for a chronic inflammatory lesion. Only an x-ray examination or biopsy of the area could reveal the true nature of the process.

SUMMARY

1. Breakage of a thermometer in the mouth was followed two years later by the development of a submental tumor mass and an enlarged tender right submaxillary gland. At surgery it was found that the thermometer bulb tip had penetrated the submaxillary duct and was lodged adjacent to it. The mercury released had filled the duct system of the gland and had also gravitated through a sinus tract to the submental skin.

2. This represents the only reported case of serious consequences following the breakage of a thermometer in the mouth.

3. It is postulated that mercury deposited in the tissues of the floor of the mouth would probably gravitate to the upper part of the neck rather than being extruded into the mouth.

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Rupture of an Abdominal Aortic Homograft, with Ileal Fistula

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SINCE Gross' [6] epic use of a frozen homograft to bridge a coarctation of the aorta in 1948, and Dubost's [5] replacement of an abdominal aortic aneurysm with a preserved homograft in 1951, hundreds of grafts have been used by many surgeons with success. DeBakey and Cooley [3] have pioneered in the replacement of aortic aneurysms in the abdomen and thorax with preserved homografts, with brilliant results.

The initial excellent results in this treatment of aortic aneurysms have been tempered by recent reports of postoperavive and late complications such as aneurysmal dilation, calcification and rupture of the homograft. Occasional reports of ruptured homografts are appearing. While the ruptures have been primarily at the suture line, several have occurred in the graft itself. Barnes et al. [1], in reviewing their experience with 165 homografts, seventy-eight of which were of the abdominal aorta, described three cases in which the graft wall had ruptured, two at the midpoint on the eighth and forty-second postoperative day, and the third into the duodenum at sixteen months. In the first patient, a second homograft was inserted with subsequent fatal re-rupture at a suture line due to cystic medial necrosis of the graft.

Humphries and his colleagues [7] reviewed 120 operations, of which ninety were successful. There were five homograft ruptures: one due to infection on the fifteenth postoperative day, another at the common iliac segment of the graft on the twelfth postoperative day, and three ruptures into the bowel on the fifteenth, sixteenth and 122nd postoperative day, respectively. The last of these occurred at the site of a previous V-plasty in the graft.

Thus, reported ruptures of homografts replacing segments of the abdominal aorta are rare, and there are but four cases in which ruptures have occurred into the bowel.

In the following case, after three years without symptoms, an aortic bifurcation homograft ruptured into the ileum.

CASE REPORT

The patient, a sixty-two year old white man, was admitted to the Portland Veterans Hospital on November 12, 1957, with the complaint of copious rectal bleeding beginning the morning of admission. In January 1952, he had undergone exploratory laparotomy at a private hospital for severe right mid-abdominal pain. A saccular aneurysm of the aorta was discovered, which led to his first admission to this hospital for further study and treatment. On February 5, 1952, 300 feet of No. 36 stainless steel wire were inserted into the aneurysm with relief of the abdominal pain. In December 1954, because of enlargement of the wired aneurysm, it was decided to replace it with an aortic homograft. On December 27, one of us (R. A. W.) excised an aneurysm measuring 17.4 cm. in length and 13.2 cm. in width, extending from 4 cm. below the left renal vein to and including both common iliac arteries, and replaced it with an abdominal aortic homograft. (Fig. 1A.) Following this operation the patient had an uncomplicated postoperative course and remained asymptomatic for three years until admission in 1957.

Physical examination revealed a well developed, well nourished white man showing clinical signs of shock with a blood pressure of 80/50 mm. Hg. His abdomen was flat with normal bowel sounds and only minimal tenderness to palpation in the epigastrium.

The patient was stabilized after administration of 500 cc. of dextran and 500 cc. of whole blood. Nasogastric aspirate was clear, and sigmoidoscopy

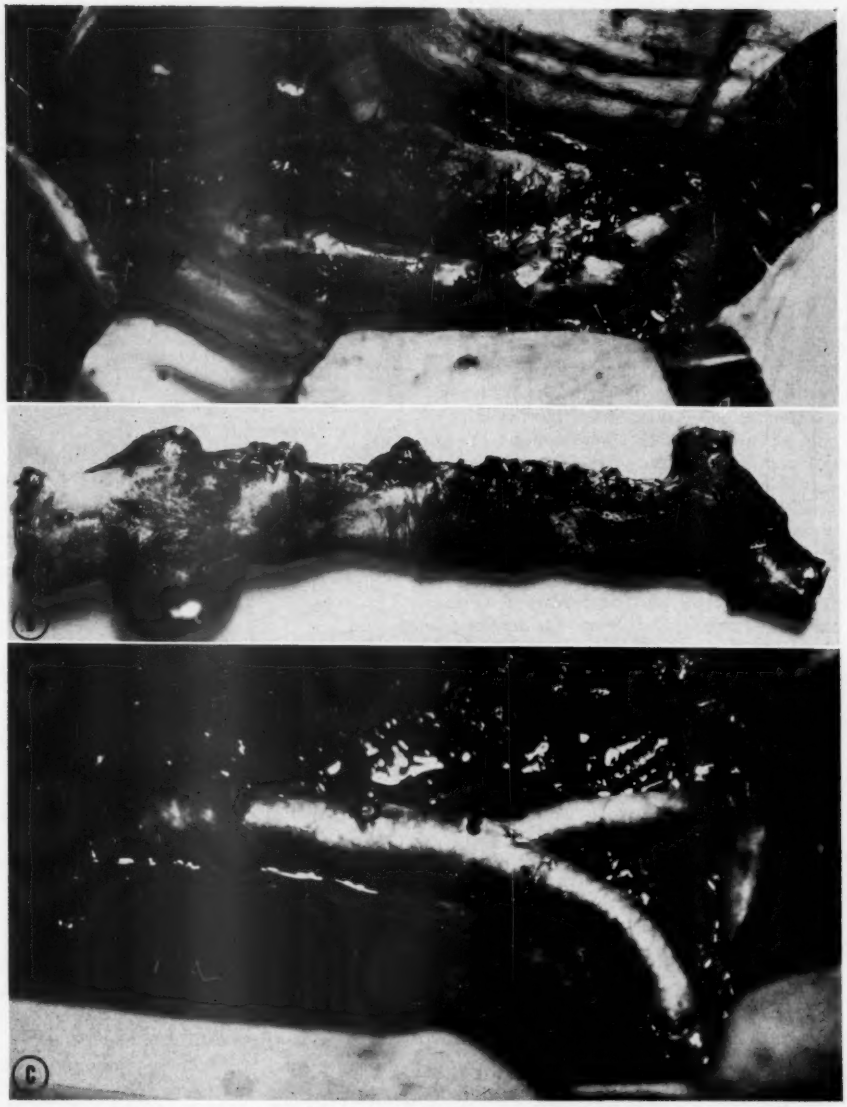

FIG. 1. A, abdominal aortic homograft placed December 27, 1954. B, the aortic homograft at the time of the second rupture showing the point of perforation and two aneurysmal dilatations. C, the second aortic homograft placed January 8, 1958.

to 18 cm. showed no abnormalities other than old blood clots. Because of the past history of a duodenal ulcer the patient was started on a Sippy regimen. Twenty-four hours later, however, he again had massive melena and exploratory laparotomy was performed for a bleeding peptic ulcer. Examination of the duodenum revealed a 1.5 cm. active ulcer of the posterior wall for which a Billroth II type of subtotal gastrectomy was performed. The aortic homograft was palpated without extensive exploration. The only abnormality noted was a 2.5 cm. aneurysmal bulge near the proximal end of the graft. The patient did well following gastrectomy until the twenty-seventh postoperative day when he again had a massive bloody stool which presented as a cast of the small

bowel. His blood pressure, which was 40/0 mm. Hg, was re-established to a normal level with the administration of 1,500 cc. of whole blood. At operation on December 11, 1957, a fistula 8 mm. in diameter was found between the anterolateral surface of the homograft and the mid-ileum. Since there was no apparent deterioration of the graft wall at the site of perforation, the defect was closed with a continuous suture of No. 4-0 silk. The ileum was closed in two layers. After an uneventful postoperative course, the patient was discharged from the hospital on January 2, 1958.

Six days later he returned to the hospital with complaints of chills, fever, abdominal pain, nausea and vomiting of three days' duration. Examination of the abdomen revealed a pulsating mass 10 cm. in diameter in the left lower quadrant. There were palpable peripheral pulses bilaterally. That evening the patient exhibited both hematemesis and melena with a precipitous fall of blood pressure to shock levels. He was rushed to surgery where a second aortoileal fistula was discovered at the site of the previously sutured defect in the graft but in a new segment of the ileum. At this operation the old homograft was resected (Fig. 1B) and a new homograft inserted at the aortic bifurcation. (Fig. 1C.) The involved segment of ileum was resected. Following surgery the patient's blood pressure was stable. Within six hours, however, extreme toxicity developed; his temperature was 105.4°F. and pulse 142. There was no demonstrable evidence of bleeding but the patient's blood pressure dropped to shock levels, necessitating the use of vasopressors. The clinical picture was that of bacterial shock. Therefore, cortisone, chloramphenicol and intravenous Furadantin® were administered. Despite these measures he failed rapidly and died eighteen hours following surgery. Blood cultures taken prior to death subsequently revealed Staphylococcus aureus, coagulase-positive. Autopsy revealed an intact homograft.

COMMENTS

The fate of arterial homografts in dogs has been carefully reported by Sauvage and Wesolowski [9]. The maximal calcification was found in evaporated dried grafts, intermediate in freeze-dried grafts and least in the fresh grafts. Keefer and Glenn [8] observed nutrient-preserved homografts in dogs after six years of implantation. This length of time in a dog's life expectancy is comparable to thirty to fifty years in humans. One operative death yielded a specimen which showed calcification and actual bone formation in the media and in elastic fibers which extended into the host vessel. There were no atheromas or ruptures.

Studies in man have revealed several types of changes in arterial homografts [4]. Creech et al. [2] reported fragmentation of elastic fibers in the media associated with condensation of the elastic lamellae after two years. The adventitia was, however, thickened by hyalinized connective tissue. There were cholesterol clefts, in contrast to the grafts in dogs, with some calcification and occasional atheromas. The intima was replaced by a fibrinoid layer or the media was bare.

There have been no ruptures in Gross' series of cases, one original graft now being in place for eleven years. In DeBakey's first 400 grafts, after a follow-up of three and a half years, there is no instance of rupture among the survivors.

Several possible explanations for rupture of arterial homografts can be postulated: (1) infection, (2) disparity of graft and host vessel at suture line, (3) aneurysm of ligated branches, and (4) fracture of media during preparation or reconstruction of the graft.

Since most ruptures have occurred in the early postoperative period, it is difficult to account for one after three years. The site of rupture in our patient could have been at an aneurysmal dilatation of a branch stump as is shown in a renal stump. (Fig. 1B.) The continuing pulsatile force then eroded the fixed ileal wall to the point of perforation.

In view of the rapid recurrence of the aortoileal fistula after the initial suture, it is clear that local repair of the defect is hazardous in a homograft. Complete replacement is certainly the procedure of choice.

SUMMARY

Although the initial results of arterial homograft replacement have been brilliant, it is apparent that ruptures are becoming more common. Such an occurrence is reported in an aortic bifurcation arterial homograft three years after resection of an abdominal aortic aneurysm.

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Primary Retroperitoneal Pseudomucinous Cyst

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PRIMARY retroperitoneal tumors, defined as those which arise independently in the retroperitoneal space and have no apparent connection with any adult structure save by areolar tissue, are of relatively infrequent occurrence, although not extremely rare. Because of their situation, size, shape and other characteristics, these tumors are sometimes treated by the general or genitourinary surgeon and at other times by the gynecologist. They are often overlooked in the differential diagnosis and hence may be recognized only at the time of operation. There are occasions when the surgical approach might have been improved if the true nature of the lesion had been recognized beforehand.

During the past year an unusual case of retroperitoneal cyst, histologically of pseudomucinous type, was observed.

A search of available hospital records and a review of the literature did not reveal a case histologically similar to the following.

FIG. 1. Intravenous pyelogram showing outline of retroperitoneal cyst on left, slight medial displacement of left ureter and bladder deformity due to fibromyomas of uterus.

CASE REPORT

A forty-seven year old woman, admitted to Lakewood Hospital on July 21, 1957, had had excessive and irregular vaginal bleeding for the past six months and was suffering from weakness and discomfort in the lower abdomen. For the past two years the patient had noted swelling in the lower abdomen, which had gradually increased. She had occasional cramps, which lasted for two or three days, but there had been no pain or tenderness. Her appetite had remained good, but occasionally she was constipated. There were no complaints referable to the urinary tract. Her last menstrual period had occurred one week before admission.

Physical examination revealed that the heart and lungs were normal. The blood pressure was 150/80 mm. Hg. Palpation of the abdomen showed a mass in the left abdomen and flank, and two pelvic masses. The pelvic masses were hard, rounded and smooth. The left abdominal mass was soft and indefinite. On vaginal examination the pelvic masses were felt. The clinical impression was that of uterine fibromyomas and left retroperitoneal mass.

Roentgenologic studies, including intravenous pyelography, showed a large pelvic mass consistent with a diagnosis of uterine fibromyomas and another large mass situated in the lumbar area on the left side. (Fig. 1.) This was suggestive of peritoneal cyst or ectopic spleen.

The blood count showed 10.5 gm. per cent hemoglobin, 3,810,000 erythrocytes and 6,350 leukocytes. Microscopic examination of the urine

showed 40 white and 15 red cells per high power field, with a few epithelial cells. Chemical constituents in the blood were normal. Cervical biopsy showed chronic cervicitis, and uterine curettage showed secretory endometrium.

At operation on July 30, 1957, a large uterus, containing multiple fibromyomas and a large pedunculated fibromyoma, and a large retroperitoneal cyst were removed. The cyst was found in the retroperitoneal space, directly posterior to the descending colon and its mesentery. The superior pole of the cyst was overlying the inferior pole of the left kidney. The inferior pole of the cyst extended to the left iliac fossa. The cyst was removed by incising the peritoneum along the left gutter, reflecting the left colon and its mesentery from the anterior surface of the cyst. The cyst was then shelled out, finding no attachment to any of the surrounding structures.

The uterus weighed 714 gm. and measured 12 by 9.5 by 7 cm. The attached pedunculated fibromyoma measured 12 by 10 by 7 cm. The cyst weighed 470 gm. and measured 14 by 11 by 8 cm. Its surface was mostly smooth, with a few fibrous tags attached. On section the cyst contained clear, slightly viscid fluid. The wall was of the membranous type; its lining was generally smooth but some trabeculations were present. No secondary cysts were noted.

Histologic examination showed that the cyst was lined by tall columnar epithelium, with pale cytoplasm and small nuclei basally located in the cells, similar to that seen in a pseudomucinous cystadenoma of the ovary. There was no significant cellular proliferation nor actual gland formation. Nuclear pleomorphism and infiltration were absent. A mucin stain was negative. The remainder of the wall consisted of connective tissue.

The patient's postoperative course was uneventful and she was discharged from the hospital on August 10, 1957. Further examination one year later showed her to be symptom-free and her general condition was excellent.

COMMENTS

The higher incidence of retroperitoneal cysts in females than in males is probably due to retention of more wolffian body remnants in the female. In the male the müllerian ducts usually degenerate and disappear, whereas in the female they form the genital organs, with the exception of the ovaries. Remnants of this tissue could give rise to formation of cystic tumors in the male. Lloyd and Bonnett [*1*] suggested that these cysts are formed from mesodermal rests.

Cystic growths are not so common as solid retroperitoneal tumors. Melicow [*2*] found ten cysts in 162 cases, and Pack and Tabah [*3*] found five (one a teratoma) in 120 cases. In his classic article on retroperitoneal cysts, Handfield-Jones [*4*] in 1924 asserted that they were formed from urogenital remnants. He classified them as follows: (1) urogenital, including pronephric, mesonephric, metanephric and müllerian; (2) mesocolic, formed from pockets of peritoneum left between opposite serous surfaces of the mesentery and parietal peritoneum, and necessarily within the boundaries of the colon; (3) dermoid, from imperfect closure of the abdominal plates; (4) lymphatic or chylous, from developmental or obstructive phenomena of the retroperitoneal and mesenteric lymphatics, lined by fibrous tissue or endothelium; (5) traumatic; and (6) parasitic. Handfield-Jones described cysts of urogenital origin as bluish, thin-walled and rather flabby, and never tense. When they are removed they are translucent and lose their bluish tinge. There are no visible vessels in their walls. Higgins and Lloyd [*5*] noted that complications of mesenteric cysts, such as intestinal obstruction, peritonitis, hemorrhage, rupture, torsion and impaction in the pelvis, are rare with respect to retroperitoneal cysts.

The treatment of retroperitoneal cysts is surgical excision. Microscopically, the cyst is lined with cuboidal, flattened or columnar epithelium, and contains serous, chylous or other material, according to its type. Dermoid cysts may be suspected during x-ray examination if a calcified shadow is seen. These cysts may contain hair, sebaceous material and other ectodermal derivatives. Various types of cysts have been reported by Landes and Ransom [*6*], Nichols [*7*] and others.

SUMMARY

A case of an unusual histological retroperitoneal type of cyst is presented. The classification of retroperitoneal cysts, with their surgical treatment, is discussed.

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False Aneurysm in a Femoral Arterial Homograft

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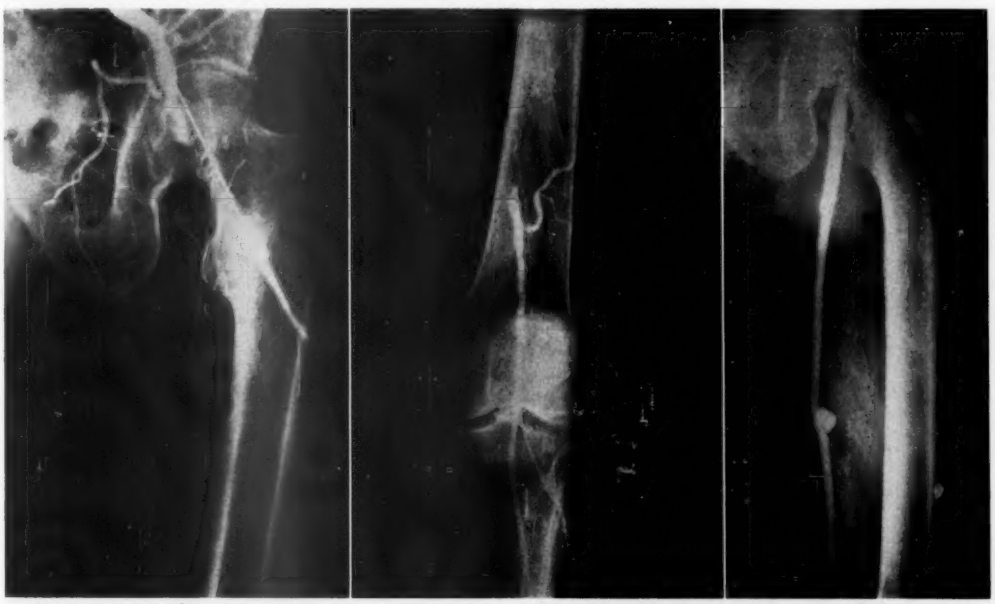
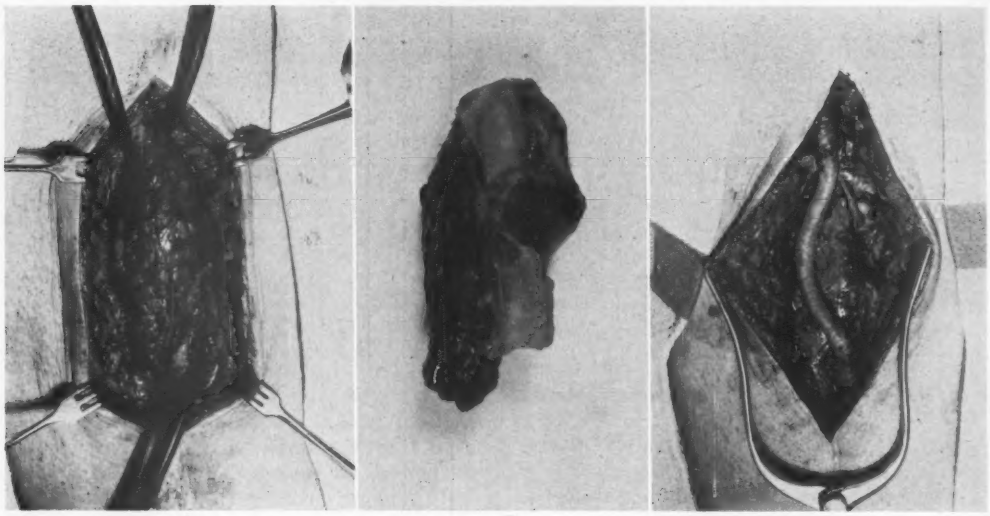
In the recent literature [*1–3,6–8*] on the fate of arterial homografts, we can find only one report of an aneurysm forming in a femoral homograft [*4*]. This apparently was a true aneurysm forming eight months postoperatively and was treated by removal of the entire graft and replacement with a second graft. There is also report of an aneurysm in an aortic homograft that was modified by plication and used in the femoral area.

This paper concerns the case of a saccular, false aneurysm in a femoral arterial homograft sterilized in ethylene oxide, freeze-dried and stored in nitrogen, occurring approximately five weeks postoperatively. Photographs of the



1A 1B 1C

FIG. 1. A and B, preoperative percutaneous femoral arteriograms using 50 per cent Hypaque® demonstrate the block in the superficial femoral artery. There is good reconstitution at the proximal popliteal artery and good outflow into the anterior and posterior tibial arteries. C, four-week postoperative percutaneous femoral arteriogram demonstrates the 1.5 cm. saccular aneurysm in the mid-portion of the homograft. The end-to-side anastomoses are visualized above and below.



2A 2B 2C

FIG. 2. A, surgical exposure of the 6.5 by 2.5 by 2.5 cm. organized hematoma about the aneurysm with the uninvolved homograft isolated above and below. B, the resected specimen has been opened showing the 1.5 cm. saccular aneurysm with its opening leading directly into the homograft. C, surgical exposure after resection of 8 cm. of the homograft including aneurysm and hematoma, and with a new homograft sutured in place with an end-to-end anastomosis above and below.

FIG. 3. Postoperative percutaneous femoral arteriogram showing good flow through the entire homograft. Note the slight bowing of the newly anastomosed homograft in Figs. 2C and 3.

arteriograms and the excised surgical specimen are included to illustrate all phases of this unusual and interesting case.

CASE REPORT

The patient was a sixty-seven year old white man who, two years previously, had had limited endarterectomy of the proximal superficial femoral artery performed at another hospital. The claudicating pain, however, returned shortly after operation and continued until the present entry into the hospital.

Physical examination revealed a well healed, diagonal scar in the anterior medial aspect of the left thigh. Both femoral pulses were palpable, but the popliteal and pedal pulses were not felt in the left leg. A percutaneous femoral arteriogram with the patient under local anesthesia demonstrated a block of the superficial femoral artery just distal to the profunda femoris artery, with good reconstitution at the proximal popliteal artery. (Figs. 1A and B.)

The patient was taken to surgery and, while under spinal anesthesia, a left femoral by-pass, utilizing a freeze-dried femoral arterial homograft, was placed subcutaneously from the common femoral artery to the popliteal artery. The homograft was 38 cm. in length and was made by an end-to-end anastomosis of two shorter segments of femoral homograft. An end-to-side anastomosis of

the type described by Linton and Menendez [5] was accomplished proximally and distally, employing No. 4–0 arterial silk. The resultant arterial flow was satisfactory.

The immediate postoperative course was uneventful with excellent restoration of the pedal pulses. Four weeks postoperatively, a 2 by 3 cm. pulsating mass was noted subcutaneously overlying the homograft in the mid-thigh. This pulsating mass gradually enlarged during the next several days. A percutaneous femoral arteriogram demonstrated a 1.5 cm. saccular aneurysm in the mid-portion of the homograft. (Fig. 1C.) The patient was taken to surgery, and the subcutaneous bed of the homograft explored, revealing a hematoma 6.5 by 2.5 by 2.5 cm. (Fig. 2A.) In the center of this hematoma was a 1.5 cm. saccular aneurysm with its opening leading directly into the homograft. (Fig. 2B.) An 8 cm. section of the homograft including the aneurysm and hematoma was removed, and a new freeze-dried femoral arterial homograft was sutured in place with an end-to-end anastomosis. (Fig. 2C.)

Postoperatively, the patient made an excellent recovery, pedal pulses remaining strong. A post-operative percutaneous femoral arteriogram demonstrated a good flow with no evidence of aneurysm or obstruction. (Fig. 3.) Follow-up examination at ten months revealed no return of claudication, the persistence of pedal pulses, and unlimited tolerance to work.

An attempt was made to elucidate the etiology of the false aneurysm forming in the freeze-dried femoral arterial homograft. It did not occur at the end-to-end suture line of the two short arterial segments utilized in forming the long graft, nor did it occur at a site of ligation of the small arterial branches off the homograft. Careful histologic study with serial microscopic sections of the excised specimen was made, and attenuation of the graft itself was believed to be the etiological factor. (Fig. 2B.)

SUMMARY

A case is presented in which a false aneurysm formed in a femoral arterial homograft, presumably due to attenuation of the wall of the graft. This was successfully treated by excision of the aneurysm and the insertion of another graft.

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An Unusual Complication of Hiatus Hernia

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HERNIATION of the abdominal contents into the chest through diaphragmatic hernias is not uncommon. Several unusual cases have been reported recently [*1–6*]. In extensive reviews of the literature [*7*] strangulation has been found to be exclusively a complication of traumatic and congenital hernias. In hiatal hernias, stricture is much more common than incarceration, and neither occur with significant frequency [*8*].

We wish to report an unusual case of an unsuspected carcinoma of the mid-transverse colon. This presented itself as an incarceration in a pre-existing paraesophageal hiatal hernia.

FIG. 1. Barium enema study. Note the colon filling to the mid-transverse region at which point the colon turns superiorly. There is minimal reflux of barium proximal to the obstructing lesion (retouched).

CASE REPORT

P. L., a seventy-three year old white woman, entered the Douglas County Hospital on the Creighton Surgical Service on August 27, 1958. In July 1958, she had been admitted to the medical service because of a vague complaint of "gas." Upper gastrointestinal x-ray series at that time showed a rather large esophageal hiatal hernia. The results of gallbladder studies, an intravenous pyelogram and a barium enema were within normal limits.

The chief complaint of the patient when readmitted in August was one of painless abdominal distention of two days' duration. She also complained of nausea and obstipation of the same duration but denied any history of vomiting, hematemesis, melena or epigastric pain. There was no history of intolerance to food.

On examination, the patient presented the picture of a poorly nourished, disoriented, apathetic, elderly, white woman in no acute pain. Positive physical findings were limited to the abdominal examination. The abdomen was distended, tympanitic, and without any tenderness, masses or fluid waves. Bowel sounds were hypoactive, metallic in character, and occasional borborygmi in rushes were heard. No apparent incarcerated hernias were present. Rectal and proctoscopic examinations were non-contributory.

A hemogram demonstrated immature white blood cells but no leukocytosis. Examination of the urine showed a 2 plus reaction for albumin, and the sediment had 50 to 60 white blood cells per cc. Serum sodium, potassium and carbon dioxide combining-power studies were within normal limits. The serum chloride determination was 80 mEq./L., and the non-protein nitrogen was 22.5 mg./100 ml.

Roentgenologic examination of the abdomen

showed gaseous distention of the small bowel and the right colon, fluid levels in the small bowel, and intraperitoneal fluid. Barium enema studies showed the colon filling to the mid-transverse region at which point it turned superiorly. On lateral fluoroscopy there was a suggestion of some projection above the diaphragm. The barium column met an obstruction at this point. (Fig. 1.)

A preoperative diagnosis of incarcerated transverse colon in the previously known diaphragmatic hernia was made. The patient was taken to the operating room where she underwent exploration through an upper midline incision. A stenosing, napkin-ring lesion of the mid-transverse colon was reduced from its incarcerated position in the diaphragmatic hernia. No lymphadenopathy was palpated. The surgeon could not be sure of the diagnosis which seemed clinically to be either ischemic contracture or carcinoma of the colon. Because of the absence of preparation with antibiotics, the gross distention of the proximal colon, and the lack of a definitive diagnosis, right transverse colostomy was performed with the lesion being exteriorized as described by Bloch many years ago. Subsequent biopsy proved the lesion to be adenocarcinoma. Transverse colectomy was performed three weeks later. The postoperative course was uneventful. Final microscopic diagnosis was adenocarcinoma of the colon with no nodal metastasis.

SUMMARY

An unusual complication of diaphragmatic hernia is reported.

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Postmortem Cesarean Section

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THE Roman senate in 715 B.C. decreed that no woman advanced in pregnancy would be placed in the sepulchre until the child had been removed from her body [1]. There are similar laws in the Talmud and the Roman Catholic Church. Since the Roman decree, 2,673 years have passed with 117 successful postmortem cesarean sections reported. This is approximately one every twenty-two years.

Virgil stated that Mercury delivered Dionysius from Semele, and Aesculapius was delivered from the belly of his mother by Apollo [1]. Findley [1] writes that Dr. Felkin in 1879 witnessed a cesarean operation performed by a native specialist in Uganda. The high degree of specialization developed by such primitive peoples suggests that it may have been performed for years. At first it was probably performed on dead mothers to provide a separate burial, and later, after the surprise of a few successes, to obtain a live birth.

Writings in the sixteenth and seventeenth centuries indicate that this procedure was freely performed [1]. Only Maruiceau in the seventeenth century claims saving a life but he gives no case report. In France, in the early nineteenth century, cesarean operations were commonly performed upon dead mothers after the seventh month of pregnancy. Valpeau reports one successful case in which an infant was delivered twenty-four hours after the mother's death but this is not authenticated. Between 1836 and 1848 Swartz assembled a list of 107 postmortem cesarean sections but no live births are recorded.

Postmortem cesarean sections performed in a hospital should have a better outcome. However, these patients often suffer from some long-standing disease that adversely affects the chances of survival of the unborn infant. The fetal prognosis is better in sudden rapid death of the mother than after long-continued infectious diseases, intoxication, malignancies, or blood dyscrasias [2]. It has been concluded by Linzenmeier [2] and confirmed by others [2,3], that twenty minutes was the longest time an infant could survive after death of the mother. There are no authentic cases on record to dispute this time limit.

The fetus apparently can withstand longer periods of anoxia than the adult or infant. None of the reports indicated any evidence of cerebral damage from the antepartum anoxia. The changes, if any, cannot be determined except by supposition. In one report [4], the oldest child reported upon was, at the time, over three years old and quite healthy. Straith reports having delivered a healthy male infant by postmortem cesarean section during the influenza epidemic in 1919. This person is alive and well today to the best of Dr. Straith's knowledge [8].

There still exists some controversy about the legality of the procedure. We believe the problem concerns two separate beings, each with equal rights for survival. If the mother dies suddenly, no more than twenty minutes has elapsed and there is clinical evidence of fetal life, then cesarean section is justified. The total number of successful postmortem cesarean sections reported, 117 [2,4–7], is sufficient evidence that the procedure is worth while, *res ipso loquitor*.

CASE REPORT

The patient was a twenty-two year old white woman, gravida 1, weighing 110 pounds, and approximately thirty-three weeks pregnant. She was brought to the Emergency Department of Hurley Hospital at 11:55 P.M. on January 15, 1958, and was pronounced dead on arrival. Her pregnancy had been quite normal but there was a long history from childhood of frequent severe episodes of "coughing," often to the point of cyanosis. She had been awakened because of a bout of coughing, rapidly followed by dyspnea and cyanosis suggesting an acute asthmatic episode.

The exact time of her death could not be established but it probably occurred a few minutes prior to her arrival. The fetal movements were active, but fetal heart tones were weak with a rate of only 60 per minute. A classical cesarean section was performed in the Emergency Department and a 5 pound, 10 ounce, well developed, male infant was delivered at 12:05 A.M. Nothing abnormal was noted in the uterus; the amniotic fluid was not meconium stained.

The infant was cyanotic at birth, exhibited extreme flaccidity of all musculature and made no respiratory movements. The fetal heart tones, weak initially, improved with positive-negative oxygen resuscitations, and respiration commenced after fifteen minutes. The infant was kept in an incubator and twenty-four hours of oxygen therapy markedly improved his condition. Respiration became normal and muscle tone returned. Progressive improvement was noted until his discharge eight days later. He has been seen at semi-weekly intervals since discharge and is progressing satisfactorily.

Postmortem examination of the mother showed only flattening of the frontal bones and the bridge of the nose, which her parents state was due to an injury in infancy. The microscopic picture was very interesting: (1) bronchi showing anatomic features as seen in bronchial asthma and extensive osseous metaplasia of bronchial cartilage; (2) emphysema and edema of lungs; and (2) diffuse internal hyperostosis of the calvaria.

Death was probably due to an acute asthmatic attack coupled with poor diaphragmatic movement and lowered pulmonary function because of the osseous metaplasia of the bronchial cartilage.

Acknowledgment: I wish to thank Dr. R. Romanski, pathologist, St. Joseph's Hospital, Mt. Clements, Michigan, for his assistance in this case report.

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Chondromalacia of the Fabella

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From the Orthopedic Service, Veterans Administration Hospital, Grand Island, Nebraska.

LESIONS of the fabella are uncommon. Osteochondritis [3], impingement [6] and fractures [4–5] have been reported. However, a survey of the literature discloses a total of only six cases of chondromalacia of the fabella [1–2].

This case is reported because of the rare incidence of the lesion, and to demonstrate the complete recovery which follows excision of the diseased sesamoid.

CASE REPORT

H. W. F., a thirty-nine year old, white, married, male farmer was admitted to this hospital on December 2, 1957. He stated that in August 1957, pain in the left popliteal region had developed. There was no history of trauma. The pain gradually increased and became particularly severe on walking or standing. He also noticed an inability to straighten the left knee. Physical examination revealed: One and a half inches of atrophy of the left thigh as compared to the right; limitation of extension of the left knee to 160 degrees and flexion to 65 degrees; exquisite tenderness to palpation on the insertion of the lateral head of the left gastrocnemius muscle. Roentgenograms (Fig. 1) revealed a 2 by 1 cm., ovoid and mottled left fabella, with alternating radiolucent and opaque areas. There was no fabella on the right side.

FIG. 1. Roentgenogram of right knee showing mottled fabella.

FIG. 2. Operative specimen.

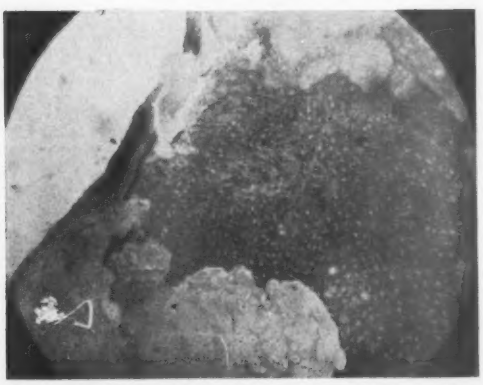

FIG. 3. Low power photomicrograph of specimen. New cartilage surrounds degenerating cartilage.

On December 5 the fabella was excised. It was found directly under the attachment of the lateral head of the gastrocnemius muscle. Examination of the gross specimen (Fig. 2) showed a disc shaped piece of tissue measuring 2 by 3 by 1.5 cm., with many small, granular nodules protruding from its lateral surface. The medial surface was smooth and glistening. Microscopic examination (Fig. 3) showed many areas of new cartilage being developed irregularly, most of them in the external surface of the specimen. There were many small areas of degenerating cartilage enmeshed and surrounded by the new cartilage.

The patient recovered uneventfully. On the second postoperative day, ambulation and an active exercise program were started, and he was discharged on December 16, 1957. At re-evaluation four months later, the patient had no complaints and the range of motion of the left knee was normal.

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Surgery Court Cases

HOWARD NEWCOMB MORSE,* *Atlanta, Georgia*

SWANSON VS. HILL

District Court of the United States for the District of North Dakota

166 F. Supp. 296

During the course of a serious surgical operation at Grand Forks, North Dakota, two surgeons left an instrument commonly described as a Kelly forceps, approximately 6½ inches long, in the patient's abdominal cavity.

The surgeons made some search of the operating area but because of the precarious condition of the patient time was of the essence and they judged it absolutely necessary to complete the surgery as speedily as possible.

Subsequently, after the patient had undergone pain and suffering for some time, surgeons in another state by means of x-ray films and examination discovered the Kelly forceps in her abdomen. The forceps had pierced the transverse colon. An operation was performed by the out-of-state surgeons and the forceps was removed.

The patient and her husband brought an action in the District Court of the United States for the District of North Dakota against the North Dakota surgeons for malpractice. The District Court rendered judgment for the patient.

The Court declared: "If the ordinary exploration for instruments or other foreign bodies could not have been made by reason of the patient's physical condition, one need not be a surgeon to suggest that professional prudence would have indicated a postoperative x-ray and examination in the area of surgery."

TAYLOR VS. MILTON

Supreme Court of Michigan

353 Mich. 421, 92 N. W. 2d 57

The patient, a laborer, being unable to pass his urine, went to see a doctor. The surgeon inserted a catheter, to which was attached a filiform, through the patient's urethra for the purpose of relieving a stricture and thus giving relief. During the operation a portion of the filiform broke off from the catheter and ultimately passed into the bladder.

The patient filed an action in the Circuit Court of Wayne County, Michigan, against the surgeon. He offered in evidence one end of a broken filiform. He also introduced in evidence a sworn statement that subsequent doctors at the University of Michigan Hospital had shown him this immediately after operating to remove it from his body. The surgeon had in his possession the other end of the broken filiform. The court rendered judgment for the patient, and the surgeon appealed.

The Supreme Court of Michigan affirmed the decision of the court below. The Supreme Court held that if the end of the broken filiform which the patient offered in evidence was not authentic, the surgeon, having possession of the other end, "could easily have refuted the authenticity of the offered one."

* Counsellor at Law of the Supreme Court of the United States of America.

HUNDLEY VS. ST. FRANCIS HOSPITAL

District Court of Appeal of California

327 P. 2d 131

This was an action against a surgeon for malpractice. The Superior Court of San Francisco County, California, entered judgment for the patient, and the surgeon appealed.

The condition requiring surgery was a dropping of the uterus. Also, there was a preoperative diagnosis of rectocele and cystocele. During the operation the body or fundus of the uterus, and the fallopian tube and ovary were removed (one tube and ovary had previously been removed). The patient did not consent to these excisions. Pathologic examination of the excised tissues revealed them to be normal.

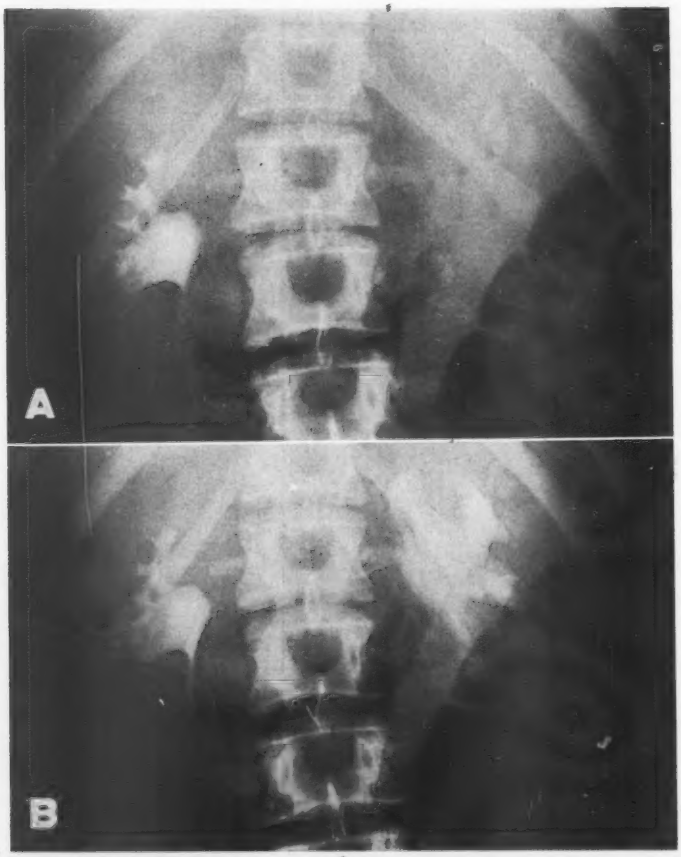
The District Court of Appeal of California affirmed the decision of the trial court. The District Court of Appeal declared: ". . . it is not accepted surgical practice to remove such organs when there are no pathological abnormalities."

The Diagnostic Corner

A problem involving trauma to the trunk without external evidence of injury but definite radiographic evidence of an important traumatic lesion.

SIDNEY W. NELSON, M.D., *Columbus, Ohio*

From the Department of Radiology, The Ohio State University Health Center, Columbus, Ohio.

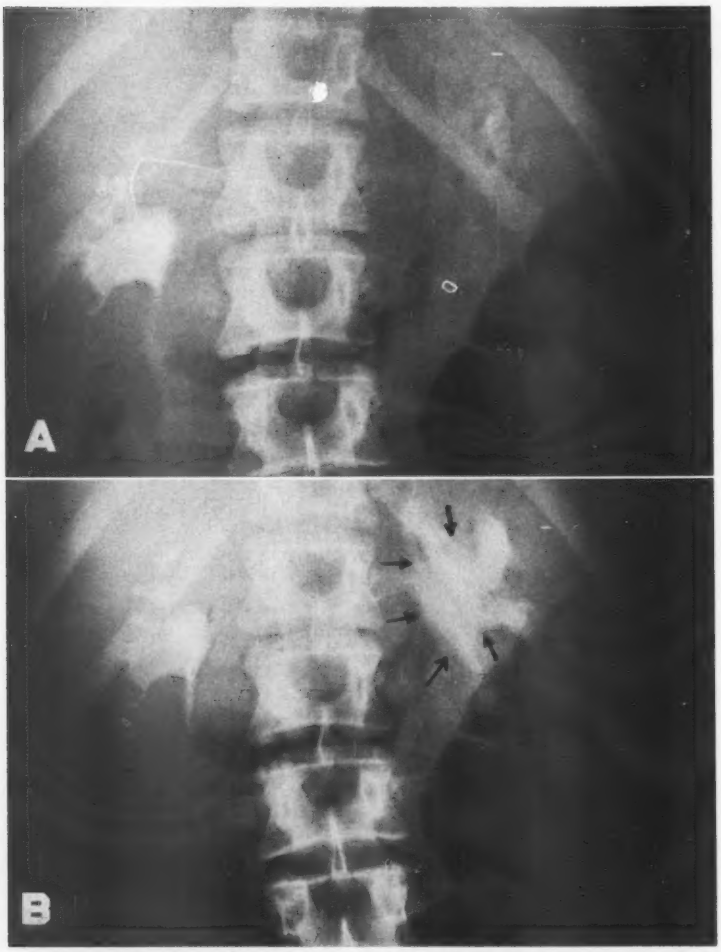


THE patient, a nineteen year old white boy, sustained a lacerated forehead and a blow to the left flank the day prior to admission to the Ohio State University Hospital. Following the accident the patient had vomited occasionally, and painless hematuria had developed associated with the pain in the left flank and left costovertebral angle. The only abnormal physical findings on admission were those of tenderness in the left upper quadrant and left mid-abdominal quadrant, with marked muscle guarding of the entire left side of the abdomen. There was splinting of the lower left rib cage and tenderness to palpation and percussion in the left costovertebral angle.

An intravenous pyelogram was performed because of these symptoms. The film made ten minutes following injection of the contrast material showed normal visualization of the right urinary system, but non-visualization of the left (A, opposite). A film made thirty minutes after injection showed a good concentration of the contrast material in the left renal area (B, opposite). The appearance of the excreted contrast material in the left kidney should suggest the nature of the lesion. *What is your diagnosis?*

Please turn page for answer

Diagnosis: Contusion of the left kidney with extravasation of excreted contrast material from the lacerated renal pelvis into the contused area.



When an intravenous pyelogram shows definitely delayed excretion on the side of known trauma to the flank in a patient without a history of previously existing renal disease, it is presumptive evidence of renal trauma. However, when delayed pyelogram films show good density of the excreted contrast material as in the case discussed herein, the diagnosis becomes clarified. The density of the excreted contrast material is so good on the abnormal side that the calyces and pelvis should be sharply outlined if all the contrast material was located within these structures. However, the outline of the contrast material (see films opposite) is very hazy and indistinct, extending beyond the expected outline of the renal pelvis and some of the calyces. (Compare the irregular hazy outline of the left renal pelvis and calyceal system [arrows] with the sharp outline of the corresponding normal structures in the right kidney.) These findings in themselves are quite reliable evidence of extravasation of contrast material from the calyces into the renal parenchyma or from the renal pelvis into the peripelvic tissues.

Subsequent pyelograms showed blood in the renal pelvis. However, the patient improved rapidly on supportive management, and surgery was therefore deemed unnecessary. He was discharged nineteen days after admission and has remained well during the subsequent ten months.

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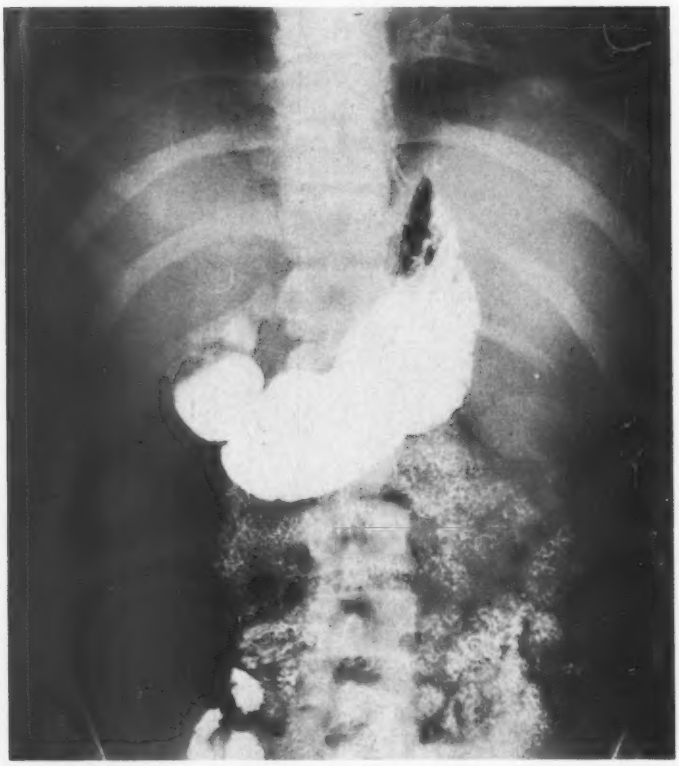
The Diagnostic Corner

An interesting type of mass in the left upper quadrant of the abdomen occurring in a teenage boy.

SIDNEY W. NELSON, M.D., *Columbus, Ohio*

From the Department of Radiology, The Ohio State University, Columbus, Ohio.

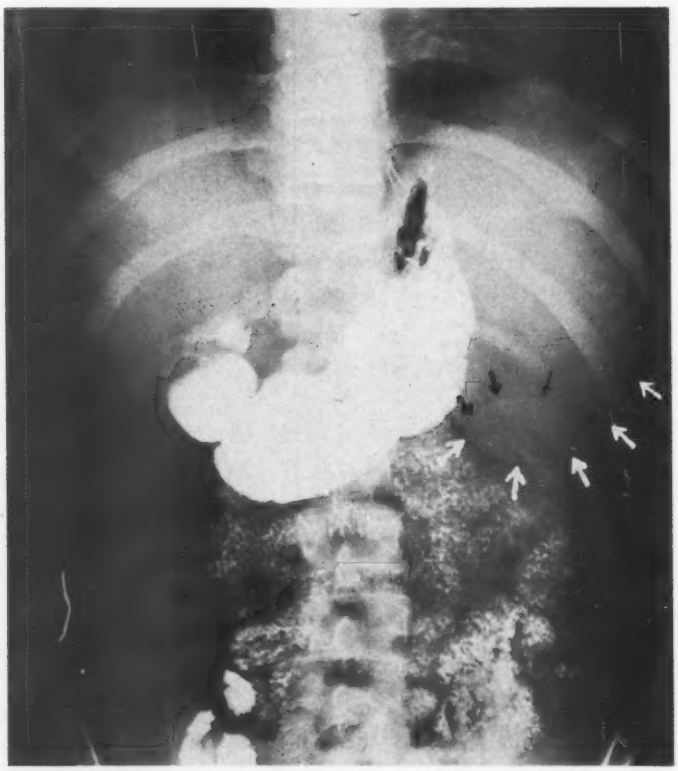


THE patient, a sixteen year old white boy, was admitted to the Ohio State University Hospital on February 18, 1958, because of an aching type of pain in the left upper quadrant of the abdomen which he had first noted during the latter part of December, 1957. This distress often occurred after meals, although it also occurred two or three hours following meals. He stated that his appetitie was good but he had, nevertheless, lost 17 pounds in weight since the onset of his illness. The patient had always been in good health until his present illness. He had done hard manual labor on a farm and indulged actively in many sports, although he had decided to give up football after the 1957 season because he had been kicked in the abdomen on several occasions.

A few days prior to admission to the University Hospital he had been examined by the family physician who noted a mass in the left upper quadrant and slightly enlarged peripheral lymph nodes. The patient was therefore admitted to the Hematology Service where an exhaustive hematologic work-up failed to show evidence of any hematologic disorder. The abdominal mass in the left upper quadrant did not have a sharp edge but did descend on inspiration and was tender to palpation. An intravenous pyelogram showed the left kidney to be displaced downward and laterally but it was otherwise normal. The x-ray film opposite shows the barium-filled stomach displaced toward the midline by a large, sharply outlined mass in the left upper quadrant of the abdomen. It was decided to perform exploratory laparotomy. *What is your diagnosis?*

Please turn page for answer

Diagnosis: Subcapsular encysted hematoma of the spleen (false, or secondary, cyst).



The spleen was removed with the attached thin-walled cyst. Biopsy specimens of the liver and retroperitoneal nodes were obtained at surgery. Histologic sections of the biopsy specimens of the spleen, liver and retroperitoneal nodes were all normal. The blood-containing cyst had no structure. The splenic cyst was believed to have been traumatic in origin in view of the history of abdominal trauma during the fall football season in 1957 only a few weeks before the symptoms were first noted by the patient.

The roentgenographic findings (see x-ray film opposite) are not in themselves diagnostic of a splenic cyst but do clearly indicate a retroperitoneal mass as manifested by the downward displacement of the left kidney. Furthermore, the mass did not arise in the left kidney because the superior pole of the kidney (black arrows) could be clearly seen through the superimposed mass (white arrows). There is no evidence of any organ resembling a normal spleen which, if present, should be discernible through an overlying mass on abdominal x-ray films of such good quality. This fact is further evidence in favor of the mass being a large spleen. Traumatic pseudocysts of the pancreas are extremely rare in the tail of the pancreas, from which area this cyst would have to arise if it were pancreatic in origin.

Thus, although the preoperative radiologic evidence points to an enlarged spleen, there is also a pertinent history of repeated, although not severe, instances of abdominal trauma shortly before the symptomatology began. An exhaustive preoperative medical work-up failed to disclose any evidence of systemic disease, which lends support to the idea that the enlarged spleen is not due to any hematologic, infectious, pancreatic or metabolic disorder but probably due to a so-called false (or secondary) cyst. About 80 per cent of all splenic cysts are the so-called false, or secondary, cysts, the walls of which are not lined by a secretory membrane, in contrast to the true (primary) splenic cysts which are lined by a secreting membrane. Approximately one-fourth of the false splenic cysts are preceded by trauma to the left upper quadrant of the abdomen or left lower side of the chest. It is of interest that some of these false cysts may develop very slowly after trauma, some reported as having become manifest several years later. The majority of the false splenic cysts related to antecedent trauma contain old blood, cholesterol, etc., as in the case presented herein, although a few may contain serous or lymphatic fluid instead of old blood.

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Case Analysis Clinic

The management of villous adenoma complicated by electrolyte depletion.

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From the Department of Surgery, Ohio State University Medical Center, Columbus, Ohio.

PATIENT D. Y., a sixty-five year old white male printer, was readmitted to the surgical service with a one-year history of progressive weakness, weight loss and intermittent diarrhea. This was characterized by passage of mucous stools per rectum distinctly separate from his daily bowel movement. The mucous passage had become more frequent, and at the time of admission he was having an many as ten passages each day. He had recently gone to Florida but, because of increasing symptoms, a local physician advised him to return home for definitive surgery as soon as possible. During his return journey by automobile, he was hospitalized twice for the intravenous administration of fluids. On the second hospitalization barium enemas were given. The patient was referred here with a diagnosis of obstructing carcinoma of the rectosigmoid.

FIG. 1.

Past history on admission was otherwise not remarkable. The patient had had hemigastrectomy and vagotomy with a Billroth 1 anastomosis for duodenal ulcer five years before this admission. He had also had suprapubic prostatectomy three years before admission without sequelae. He had maintained his weight fairly well until the present illness began. He had not, however, regained his ideal weight. He had experienced no other symptoms before the present admission.

PHYSICAL EXAMINATION

The patient was in no acute distress or pain but was found to be markedly dehydrated. The turgor of his skin was that of "chewing gum." The pulse was 84, the temperature 99.4°F., the blood pressure 136/70 mm. Hg. Respirations were 20 per minute, quiet and somewhat shallow. There was moderate abdominal distention, and bowel sounds were almost completely absent. No abdominal rebound or guarding to palpation was found but there was diffuse tympany to percussion. There were well healed abdominal incisions in the upper and lower midline. No evidence of hernia was found. The heart and lungs were normal. There was a palpable mass high in the rectum. It seemed to be extremely soft and almost identical to a redundant fold of rectal mucosa. No firm mass was palpable.

* Present address: U.S. Naval Construction Battalion Center, Port Hueneme, California.

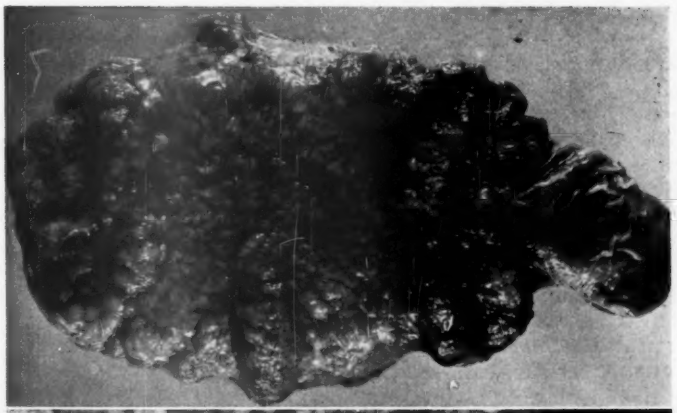

FIG. 2.

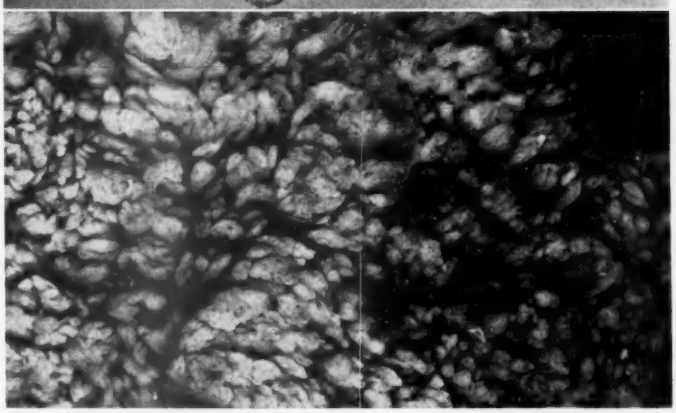

FIG. 3.

LABORATORY DATA

Emergency x-ray films, taken at the time of admission included a film of the chest and recumbent and erect films of the abdomen. These showed an apparent partial obstruction of the large bowel. There was distention of the entire colon, scattered barium throughout and several small loops of air-containing small bowel. The chest was normal. Hemoglobin was 12.7 gm. per cent, hematocrit 40 per cent, and the white count was 16,700 per cu. mm. (neutrophils 79 per cent, lymphocytes 15 per cent, monocytes 3 per cent, eosinophils 3 per cent). The results of the serologic were negative. The blood urea nitrogen was 23 mg. per cent. The urine had a pH of 6.5, specific gravity 1.030; there was no sugar or albumin; microscopic examination of the urine was not remarkable. The serum electrolytes included sodium 137 mEq./L., chloride 78 mEq./L., and potassium 2.4 mEq./L. The CO_2 was 92 per cent.

MANAGEMENT

Laboratory data indicated severe hypokalemic alkalosis. In view of this and the clinical findings, a tentative diagnosis was made of partial intestinal obstruction and secondary electrolyte imbalance. This was confirmed by sigmoidoscopic examination. The sigmoidoscope was passed with some difficulty through an estimated 15 cm. of tumor mass. For another 13 cm. beyond the tumor there was clean and uninvolved bowel lumen. The appearance of the tumor was startling. Many massive fronds of tissue were waving in huge quantities of mucus. During sigmoidoscopy more than 400 cc. of crystal clear mucus was aspirated, even though the patient was markedly dehydrated at the time of examination. The tumor mass did

not bleed readily either on touch or with several biopsies.

Excision of the tumor was delayed until fluid and electrolyte balance could be established. Correction of deficits was started with replacement of 6 L. of fluid in the first twenty-four hours. Four of these were saline and dextrose solutions, with 120 mEq. of potassium. One unit of whole blood was given. The patient responded immediately and dramatically. He became more alert and cooperative. His bowel sounds returned to normal, and the distention began to subside. After the first day, the intravenous replacement was maintained between 3,500 and 4,000 cc. per day with 90 to 120 mEq. of potassium administered intravenously. Oral supplements of kaon elixir were given. In spite of this, the serum potassium level fell further. Potassium was 2.0 mEq./L. on the second hospital day. There was a gradual rise to normal levels over the next four days with an intake of potassium (both intravenous and oral) up to 1,000 mEq. per day. The blood volume determinations showed a deficit of 200 cc. red cell mass. Total volume was within normal limits. Repeat x-ray films with barium showed the lesion to be in the rectosigmoid colon. (Fig. 1.) There was a definite shaggy pattern with filling of the spaces between the fronds of the tumor. This also suggested the diagnosis of villous papilloma of the rectum.

The patient continued to emit large quantities of mucus. This increased after his hydration. Measurement indicated that he emited 1,500 to 2,000 cc. of mucus per day in addition to the normal output of feces and urine. Electrolyte determination of the mucus indicated a loss of 114 mEq. of sodium, 120 mEq. of chloride, and 19 mEq. of potassium per liter of mucus. These findings readily explained the electrolyte status of the patient on admission.

SURGERY

For two days the patient was prepared for surgery with non-residue diet and neomycin. He was taken to the operating room on the sixth hospital day. A huge lesion of the rectosigmoid was exposed. (Figs. 2 and 3.) There was moderate proximal dilation of the colon. Anterior resection was accomplished. The suture line was completed within 5 cm. of the anus in an end-to-side manner (Baker type). The lesion was completely excised. Careful serial section was performed through the tumor mass. There were no areas suggesting malignant degeneration. The tumor mass was 10 cm. in circumference by 18 cm. in length. The postoperative course was benign except for some difficulty with voluntary micturition. Cystograms were within normal limits, and there was no outflow obstruction. After one week, the patient regained full voluntary control. In the postoperative period, stools were normal and formed. This had not happened for more than one year, according to the patient.

COMMENTS

Although several large series of villous adenomas have been reported, they are relatively rare. They are generally accepted as benign although some authors have reported an incidence as high as 68.7 per cent showing cytological carcinoma.

In the case presented herein, anterior resection was necessary because of the tremendous size of the lesion and because it extended above the line of peritoneal reflection. The relative local resection was justified by final examination of the tumor. There were no areas of malignant change.

This patient was losing more than 30 to 40 mEq. of potassium per day from mucus alone. It is of interest that even after recognition of the deficit the patient could hardly maintain his potassium level with rather large oral and intravenously administered potassium supplements. In view of this it is not surprising that his original presenting complaint was reflecting his electrolyte depletion.

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Case Analysis Clinic

Surgical management of Cushing's syndrome.

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PATIENT P. W., a twenty-two year old white man, was seen in the hospital emergency room complaining of pain in the left flank of a few hours' duration, radiating into the testicle. The appearance of the patient was striking. He had a dusky red, swollen, rounded face, and the neck was thick and bull-like. The trunk was obese, with large violaceous striae on the skin of the chest and abdomen, but the extremities were surprisingly thin. The gonads were quite small with normal growth of pubic hair. The blood pressure was 168/110 mm. Hg.

The patient reported that this change in appearance had begun two years before, when the skin striae were first noticed. At that time he had had severe headaches, flushing of the face and muscular weakness. The complaints were progressive.

The initial history and physical examination pointed to acute renal colic and Cushing's syndrome. The patient was hospitalized and laboratory studies obtained.

The complete blood count was within normal limits. Serum electrolytes were as follows: sodium, 146; potassium, 2.4; chlorides, 93; CO_2, 35 mEq./L. Urinary steroids were as follows: 17-hydroxycorticosterone, 36.8 mg./L. (normal 5 to 25 mg./L.); 17-ketosteroids, 9 mg./L. (normal, 5 to 10 mg./L.). The result of the glucose tolerance test was typically diabetic with a two hour rise to 410 mg. per cent. The urine frequently showed traces of sugar. The serum cholesterol was 230 mg. per cent; calcium, 8.8 mg. per cent; and inorganic phosphorus, 2.9 mg. per cent; basal metabolic rate, 4 per cent; and alkaline phosphatase, 9.4 King-Armstrong units. X-ray films of the skull and spine showed a normal sella turcica and marked osteoporosis of the entire spine. These studies substantiated the presence of hypercortisonism.

This syndrome, originally described by Cushing in 1932 [1], was thought to result indirectly from a functioning basophilic adenoma of the pituitary gland. However, in not every one of the twelve cases collected was there a pituitary tumor. One patient showed only adrenal cortical hyperplasia, and one presented no evidence of changes in either the pituitary or the adrenal glands.

The evidence that the disease originates in either of these glands is far from conclusive. Increased adrenal function is now considered to be practically essential for the development of all the changes seen in Cushing's syndrome. These changes may be present as bilateral adrenal hyperplasia, bilateral or unilateral adrenal adenoma, or adrenal carcinoma.

The signs and symptoms resulting from these functional tumors can be divided into two large categories: (1) those which include sexual changes and increased secretion of 17-ketosteroid, and (2) those associated with certain metabolic abnormalities due to oversecretion of 17-hydroxycorticosterone and 11-oxycorticosterone.

We are concerned herein with the second group. These patients usually have a curiously disposed obesity, osteoporosis and hypertension. There is a decrease in glucose tolerance, and purplish striae are present on the skin of the trunk. Polycythemia is seen with dusky cyanotic discoloration of the face; acneform eruptions of the skin are observed, and purpura and ecchymoses have a tendency to develop. The disease is most prevalent in adult life and considerably more frequent in females, with a ratio of four to one.

Management of this disease requires an understanding of physiology of the disturbed

body in all its ramifications. In view of the relationship of the adrenal cortical homones to carbohydrate metabolism, one can expect some disturbance to be present in about 50 per cent of the patients.

The mechanism of the disturbance depends on two factors: (1) extensive catabolism of tissue due to increased gluconeogenesis, and (2) direct interference with the utilization of glucose by the peripheral tissues. These two changes are due to increased secretion of 17-hydroxycorticosterone. Both changes are diabetogenic, that is, they increase the demand for insulin, and decrease its effectiveness.

Osteoporosis occurs in most patients with Cushing's syndrome. This process frequently involves the spine and long bones, and may result in compression fracture of the spine. Albright [3] attributes the osteoporosis to lack of bone matrix resulting from decreased activity of osteoblasts which is secondary to the disorder in protein metabolism. Continuous resorption of large quantities of calcium often leads to nephrolithiasis, the basis of the presenting symptom in the case reported herein.

Hypertension is seen in most patients with Cushing's syndrome and is manifested by increased systolic and diastolic pressure. This elevated blood pressure has a specific hormonal origin. It is independent of retention of sodium ions or of an increase in blood volume [4]. When this hypertension persists, cardiovascular-renal changes of an advanced and irreversible nature may be seen. The extensive vascular changes are due to prolonged elevation of blood pressure. Cardiac and renal failure are frequent causes of death.

Ecchymoses, purpura and petechiae tend to develop in these patients. In some instances, massive hematomas develop but are not due to any intrinsic blood dyscrasia. These changes, as well as the purple striae, can be attributed to the depletion of protein in the capillary walls and to generalized atrophy of the skin.

Adrenal cortical hormone stimulates the erythroid elements and depresses the lymphoid elements of the bone marrow. Many patients have moderate polycythemia but no increase in blood volume.

Muscular weakness and easy fatigability are outstanding symptoms and can be attributed both to a decrease in muscle mass secondary to protein catabolism and to a low level of serum and total body potassium.

The surgeon is particularly interested in two other facets of the great catabolic activity of cortisone on protein. One is the delayed onset of fibroblastic activity in the processes of wound repair; this activity may be delayed in onset by as long as six days. The second is the poor globulin response to infection. This results in increased susceptibility to postoperative wound, subdiaphragmatic, and pulmonary infectious complications.

Less than half of these patients will have changes in blood electrolyte due to oversecretion of 11-oxycorticosterone which acts by inhibiting renal tubular reabsorption of potassium.

Potassium is lost from the body in large quantities and is replaced in the cells by sodium. A great deal of sodium may be administered with only moderate rise in the serum sodium. Practically no sodium is lost in the urine. For this reason, replacement of electrolytes cannot be gauged by loss of salt in the urine. The over-all electrolyte picture is that of a hypokalemic alkalosis with low chloride, low potassium, normal sodium and an elevated carbon dioxide combining power in the serum. Withdrawal of 11-oxycorticosterone reverses this pattern by facilitating retention of potassium by the kidneys. The rapid, progressive rise in potassium in patients who have undergone adrenalectomy suggests deficiency of this hormone. There is usually an accompanying deficiency of 17-hydroxycorticosterone.

Surgical removal of the adrenal glands results in cure of the disease. The devastating effect of prolonged hypercortisonism on the cardiovascular-renal system [5] makes early removal of these glands desirable. This was true in the case being considered. For two months prior to admission and while in the hospital, the patient had frequent bouts of substernal pain. An electrocardiographic tracing showed the symmetrical sharp inversion of T waves over the precordial leads, typical of myocardial ischemia.

Three weeks after admission, transabdominal bilateral total adrenalectomy was performed [6]. The glands had grossly thickened cortices with adenoma-like nodularity throughout, and proved to be benign. It should be noted, however, that carcinoma has been found in 10 per cent of these patients. Had a unilateral adenoma been found, the opposite atrophic gland would not have been removed.

There was no need for preoperative therapy

with hormone substitution. Immediately following extirpation of the glands, an infusion of 5 per cent glucose in water with 100 mg. of hydrocortisone was administered intravenously at a moderate rate. This was supplemented at the end of the procedure and eight hours later with 100 mg. of cortisone acetate administered intramuscularly. These large doses of cortisone are given during this period of operative stress to prevent adrenal insufficiency at a time when the exact requirement is unknown.

The patient did well following surgery. His vital signs remained in their preoperative range. Cortisone was given in doses of 100 mg. every twelve hours. This amount of cortisone was thought to contain enough 11-oxycorticosterone as an impurity so that a separate supplement would not be necessary in the early postoperative period. The fluid balance was maintained for the first three days with intravenous infusions of 5 per cent glucose in water.

The dose of intramuscularly administered cortisone acetate was reduced after the third postoperative day to 50 mg. every eight hours, and the oral administration of fluids was started. On the evening of the fourth postoperative day the temperature rose to 101.5°F. On physical examination, post-tussic rales were heard in the base of the right lung posteriorly. Because of the known low resistance to infection in Cushing's syndrome, a throat culture was obtained. Then 1.2 million units of procaine penicillin were administered, and the administration repeated every twelve hours.

During the night, the patient became confused and slept fitfully. By morning he had marked abdominal distention and a temperature of 102°F. Blood pressure was 90/60 mm. Hg and the pulse rate 148/minute. The patient was breathing quite rapidly. Examination indicated the presence of acute gastric dilatation, with sequestration of a large volume of electrolyte-rich fluid in the stomach. Blood was drawn for determination of serum electrolytes and a liter of 5 per cent dextrose in saline with 100 mg. of hydrocortisone was administered intravenously at a rapid rate. A large-bore Levin tube was passed into the stomach and 1,080 cc. of gastric fluid and large amounts of air were removed. The patient's condition improved somewhat but not as rapidly as would be expected with adequate replacement of electrolytes.

In reviewing the postoperative course, it was noted that the serum potassium level had risen progressively. The determination on the previous day being 6.0 mEq./L., an electrocardiographic tracing was made with the knowledge that high serum potassium levels would be reflected in high peaked T waves. Our patient showed this change. This finding and the clinical picture of disorientation, shock and abdominal distention indicated the presence of adrenal insufficiency. One hundred milligrams of hydrocortisone was added to each of two subsequent saline infusions. Saline solutions, when given judiciously, will restore normal plasma volume, correct the failing circulation, increase the level of blood pressure and improve renal function, enabling the kidneys to better excrete potassium.

To combat the high level of serum potassium, which proved to be 7.9 mEq./L., all intake of potassium was restricted. Ten milligrams of desoxycorticosterone acetate was given intramuscularly to increase the excretion of potassium in the urine. Since potassium is utilized in the storage of glycogen by the formation of potassium-hexose-phosphate, all infusions were given as 10 per cent dextrose with 30 units of regular insulin added. By this means, a rapid reduction in the level of serum potassium can be effected. This is most desirable since cardiac arrest occurs in the presence of a high level of serum potassium.

The patient responded quickly to these measures and within a few hours had fully recovered. The level of serum potassium at this time was 5.5 mEq./L.

The remainder of the postoperative course was uneventful. The patient was given a nutritious diet containing large amounts of calcium and phosphorus. Vitamin supplements were given as well as frequent small doses of testosterone for its effect on tissue anabolism. The dosage of cortisone was reduced by increments of 25 mg. every two to three days until a maintenance dose of 12.5 mg. three times per day was reached. The dosage of desoxycorticosterone acetate was reduced to 1.5 mg. daily and thereafter was given as 0.25 mg. of 9-alpha fluorohydrocortisone, a potent mineralocorticoid. This drug has a cumulative effect; reduction in dosage should be made accordingly.

The progressive reduction in dosage of cortisone cannot always be accomplished so smoothly. The patient may become nauseated

or disturbed emotionally during the postoperative period because of severe nutritional deficiency and depletion of protein [7]. These symptoms are readily controlled by temporary increases in dosage of cortisone. Two to three days later, further attempts should be made to reduce the level of cortisone dosage.

The postoperative management of the patient failed to take proper cognizance of the rising level of serum potassium. It was above the upper limit of normal the day prior to the acute manifestation of adrenal insufficiency. Subsequently, desoxycorticosterone acetate has been given in doses of 5 mg., immediately postoperatively, decreasing the dosage as indicated.

The patient was discharged from the hospital three weeks following surgery. By this time he had begun to lose the facial plethora, and the thoracic and abdominal striae were less violaceous. We can anticipate a restoration of the over-all body contour in the next few months. Hypertension was still present on discharge and may not improve, depending upon the amount of irreversible vascular damage.

The patient was asked to return frequently to the out-patient clinic, particularly if any infection or injury should occur. In this event, the dosage of cortisone will be increased depending on the estimated stress of the situation. If an operative procedure is to be performed, the regimen of hormonal replacement would be the same as that used when adrenalectomy was performed.

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Our Surgical Heritage

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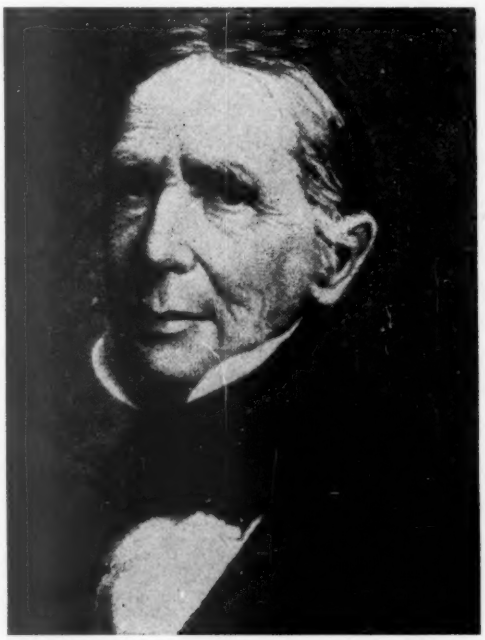
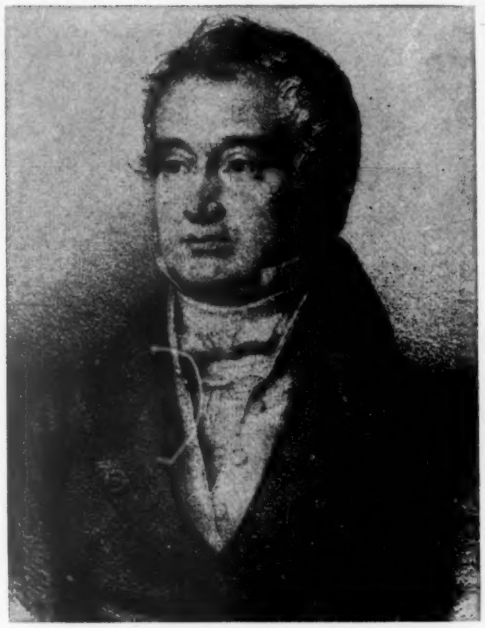


JOHN COLLINS WARREN

JOHN COLLINS WARREN was born on August 1, 1778, in Boston, Massachusetts. His grandfather Joseph was a prosperous farmer in Roxbury. Warren received his early education in the Boston Latin School from which he was graduated with honors. Thereupon, he entered Harvard College from which he was graduated in 1797. He entered Harvard Medical School but after a year's study decided to complete his education in Europe and accordingly journeyed to London. In June 1799 he became a pupil of Mr. William Cooper, then surgeon at Guy's Hospital. At the close of Mr.

Cooper's professional life his post at Guy's Hospital was taken over by his nephew, Astley Cooper, and there was formed a close bond between Dr. Warren and his distinguished teacher, which friendship lasted throughout their lives. During his sojourn in London he had the opportunity of studying with the great Abernethy at St. Bartholomew's Hospital and with Sir Everard Home at St. George's Hospital, receiving instruction in the new science of surgical pathology. In 1801 Warren received the degree of Doctor of Medicine from St. Andrews University in Scotland after which he returned to Boston and immediately acquired a large practice. In 1806 John Collins Warren was appointed adjunct Professor of Surgery at Harvard University and became a prominent figure in the work of the Massachusetts Medical Society. Dr. Warren made many contributions to surgery, among the more important being the publication in 1837 of a book "*The Surgical Observations On Tumors,*" and the use of ether anesthesia in an operation in October 1846 at the Massachusetts General Hospital of which he was a founder (1811), demonstrating the practical use of ether anesthesia in surgery. The poet Longfellow, one of his patients, said of him that he had the eye of an eagle and a woman's hand. Dr. Warren died on May 4, 1856.

EUROPE



BARON GUILLAUME DUPUYTREN

Baron Guillaume Dupuytren was the most able and best educated French surgeon of his time. He was more respected than beloved. Lisfranc dubbed him as the brigand of the Hotel Dieu.

Dupuytren was born at Peirre-Buffière in 1777, the son of a poor lawyer. His early education was obtained at the Collège de la Marche, after which he became a prosector at the École de Santé in charge of all autopsies. In 1802 he became a surgeon at the Hotel Dieu in Paris, in 1812 professor of operative surgery and in 1815 surgeon-in-chief, when he reigned supreme.

Many sayings of Dupuytren have lived on, such as, "I have been mistaken but I have been mistaken less than other surgeons." He lived and died by his maxim, "Nothing should be feared so much for a man as mediocrity."

The contributions of Dupuytren to surgery were numerous. He devised a method for making an artificial anus by crushing the spur with his enterotome (1828); he was first to excise the lower jaw with success (1812), first to treat torticollis by subcutaneous tenotomy (1822), and he described the contracture of the palmar fascia which bears his name, Dupuytren's contracture. His treatise "*Leçons Orales*" in four volumes was translated into many languages.

Dupuytren, while lecturing to students in 1833, suffered a cerebral hemorrhage which made him an invalid. He died in his beloved Paris in 1835. Thus passed the French surgeon with the most sang-froid.